EXHIBIT XI

MEMORANDUM

TO: Planning Commission

FROM: Linda Sarnoff, Planning Manager *Linda*

DATE: August 23, 2000

RE: Riverfront Commemorative Park (WRG-00-00002) - Additional Written Testimony (8/16/00 through 8/23/00)

At the August 16, 2000 Planning Commission public hearing there was a request to hold the written record open for seven days for additional written testimony. The applicant then has seven days to provide final written argument. Planning Commission deliberations are scheduled for ~~September~~ 30, 2000. Attached is the testimony that was submitted since the August 16th Planning Commission meeting.

August

Submittal Number	Name
A.	Gregory Paulson
B.	Marilyn Dilles
C.	Tony Van ~~Vleit~~ *Vliet*
D.	Peter Rabenold
E.	John Wolcott
F.	Scott Mater
G.	James Robbins
H.	Applicant's Response to New Information provided at the August 16, 2000 Planning Commission Public Hearing
I.	Riverbank Stability Analysis Peer Review for the Corvallis Riverfront Project Report to the City Council, January 3, 2000 (Not included - Copy in the Planning Division Office)

Exhibit XI

Gregory F. Paulson
Consulting Arborist
P.O. Box 1913
Corvallis OR 97339

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AUG 2 1 2000
Comm Dev Admin

Corvallis Planning Commission
Community Development Planning Div.
501 SW Madison
Corvallis, OR 97333

Regarding: WR-G00-00002, City of Corvallis, Willamette River Greenway

Dear Commission members,

I encourage you to approve the Willamette River Greenway permit for the applicant, the City of Corvallis. The City's plan for stabilization of the riverbank is based on engineering requirements, environmental science, and democratic process and review. The City's riverfront park plan, as created by two landscape architecture firms with hundreds of hours of citizen input, certainly complies with the Greenway requirement to "preserve, or mitigate the loss of, significant, natural, or scenic areas." The park plan will add greenswards, native plants, more trees, and vista areas to this previously neglected part of the city. The replacement of the existing trees, many of which have significant disorders or are in decline, with a greater number of street and park trees will provide a beautiful, ecologically rich parkland that will merge into the riparian vegetation of the riverbank. Please consider the following points:

a) the Corvallis riverfront has not been a "natural" area for 150 years,
b) these are plans for the future; New York City's Central Park was designed and installed by people on land that had been developed, it was not a natural park,
c) the use of smaller trees in new plantings has been proven in research to provide established trees of larger size faster than those plantings that used larger transplants,
d) the committment of the city to maintain the new parkland will insure long-term growth and health of the plantings.

As a consulting arborist, I prepared the Tree Preservation Plan for the Willamette Greenway Permit previously granted to the city for the C.S.O. Project. The components of that plan included evaluation of the trees and protection or mitigation measures, if needed. Only those trees within the CSO construction zone likely to be affected were evaluated. Trees above the planned tunnel sections, the 3 blocks from Adams to Jackson, and those outside the narrow construction zone were not included. Only 51 trees were evaluated in the Preservation Plan. Recently, opponents of the application have misused and erroneously extrapolated data from the CSO project to support their position in the Gazette-Times and possibly in testimony to this Commission. No formal evaluation of all of the "park trees" has been carried out by me. You are urged to disregard any testimony presented to the Commission by anyone not associated with me that supposedly interprets my data.

Respectfully,

Gregory F. Paulson 8/17/00

Gregory F. Paulson
American Society of Consulting Arborists
Certified Arborist, International Society of Arboriculture

A

August 22, 2000

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Corvallis Planning Commission
c/o Steve Lindsey

Re: Riverfront Comm. Park/Riverbank Restoration Plan
Supplemental Memorandum for Willamette River Greenway Review
For 8-16-2000, Continued Public Hearing (WRG00-00002)

From: Marilyn Dilles (please note correct spelling)
representing herself, a resident, and Friends of Riverfront, PAC

Statement of rebuttal to Supplemental Mem.

This statement is to be entered into public record.

CORRECTIONS:
p. 2, Applicant's Response, 8-3-2000 Winterowd Planning Serv., Inc.

1. Please spell DILLES correctly, as submitted. Thank you.

2. (Footnote) Friends of Riverfront does include: Dilles, Watson, and Mater. It does not include Thies, Puckett and others not listed who spoke independently as Corvallis residents, unless written specific statements otherwise indicated.

CONFLICTS WITH GREENWAY GUIDELINES/CRITERIA

Section 3.30.40 (J) "Development, change or intensification of use shall provide the maximum possible landscaped area, open space, or vegetation between the activity and the river."

The basis of staff evaluation of Exhibit 3. Existing Park Tree Survey, (Applicant's Response, p. 4, 8-3-2000, is flawed. The City of Corvallis lacks a City Arborist, whose job would have been "the proper care of trees." CARE is defined : concerned; attention to; protection; to make provision; watch over; attend.

The tone of staff analysis & conclusion suggests that our existing riverfront park trees are treated as obstacles (to concreting throughways in rigid linear ways) rather than assets.

A Salem arborist, Paul Ries of Pacific NW Chapter, International Society of Arboriculture, spoke at OSU on 8/19/00. He talked about how to kill a tree, noting that undermining its root system because of construction is terminal; and that a newly planted sapling needs at least 3, and better, 5 years of after-care to survive. "There's nothing native about 4'by4' cut-outs. There's nothing native about concrete."

The first page of the Sunday NYTimes for August 13,2000 had an article about dying tanoaks in California. "One coast live oak tree can add as much as $30,000 to the value of a property." Staff insistance on cutting 115 trees robs park lovers of $345,000 - with no guarantee that any replacement will survive its concrete jungle.

See note on last page.

B1

Rigid, letter-of-the-law views that rule out curving walkways around trees (see p. 7) to save them shows dominance of merchantile, high-tech linear over the natural intent of Greenway Statute. Nature is circular, not linear, in design.

<u>Reasons for possible tree removal</u>, p. 6, 2nd paragraph:

1. Poor health. Could this be deliberate city neglect?
2. Needed change in ground elevations & grading. Is this high tech overriding/ignoring the Greenway natural clause?
3. Construction of plaza areas. Where is flexibility to admit and embrace the circular patterns in nature?

(It needs noting by LUBA that Corvallis citizens have placed an initiative to alter present plan. It would halt draconian cutting of park trees; modify access to one-way, single lane loops; and eliminate the invasive destruction of piling to shore up an already stable riverbank.)

TRANSPORTATION IMPACT MEMORANDUM (Exhibit 1)

For: Somkeart Sartnurak, Transportation Engineer

Your analysis draws conclusions before the fact; this may be premature and risky - as well as incorrect.

A case could be made that a traffic impact analysis on any proposed new, two-way street seems badly needed.

You say "9 additional trips on a(ny) week-day?"
This is an absurd statement.
Any new street in a city with positive population statistics
<u>IS GROWTH INDUCING.</u>
Have you visited this site, especially from 5:00 p.m. to 6:00 p.m. Monday through Friday? It's an expressway!
You ignore Saturday, which is Farmer's Market Day for 1/2 a year.

Are huge trucks - P.O. mail trucks; furniture (Blackledge) trucks - to be allowed to elephant through a public park? Unless forced to do so (and all delivery trucks can use the alleyway between Riverfront and 2nd St.) trucks will short-cut through. This is trashing what the public thought was to be a park.

Recommended: the Friends of Riverfront alternative plan, which has three single lane, southbound loops, non-contiguous, so that trucks use the alleys and exit on 3rd Street. Riverfront Park becomes truly pedestrian, and safer for all people.

Section 3.30.40 (J) "Development, change or intensification of use shall provide the maximum possible landscaped area, open space, or vegetation between the activity and the river."

Applicant's Response, p. 8, 8-3-2000

5. SEPARATION OF THE RIVER FROM "DEVELOPMENT"

Definitions:

Multi-use trail (or multi-modal path) is OPEN SPACE

Parking is DEVELOPMENT (they, areas, are explicitly excluded)

Plazas are DEVELOPMENT
Sidewalks are DEVELOPMENT

Comment:

If multi-use trail is open space, it needs to be covered with native "duff". Both concrete and asphalt are inappropriate, since they are both impermeable and therefore polluting run-off. The precise type of covering needs to be re-thought and changed.

p. 9,

p. 10

The calculations, beginning at bottom of p. 9 and continued on p. 10, are misleading and incorrect.

The first sentence - "The net difference in landscaped open space (excluding the multi-use trail but including sidewalks, parking lots and plazas) between the top-of-bank and the eastern edge of dev"----etc---

ignores that parking lots are development and that Plazas are development and need subtracting from the sum total, just as two-way street and sidewalks are development and NOT OPEN SPACE.

You can't have it both ways. Things are either one thing or the other. See Definitions: Parking & Plazas are Development. FOR disagrees; the criteria "J" is better met by the Friends of Riverfront alternate. There is more pedestrian, multi-modal path in place, and developed plazas are pulled back, light-weight and flexible. <u>And</u> no huge, two-way concrete blocks needing pilings. That's a <u>$1M</u> savings.
In fact, the area labelled Farmer's Market has met with such disdain by the Market Board that we are debating whether to recommend that the Market take over the rental of the North Riverfront parking lot. That would leave us <u>more open space</u> for a children's playground/picnic area, for families to enjoy.

p. 10, 7. Use of Parkland

F.O.R. disagrees with applicant; Riverfront area has many existing streets: incoming Van Buren, Monroe, Jefferson; outgoing Jackson, Madison, and Adams. And our plan has three loops: Van Buren-Jackson; Monroe-Madison; Jefferson-Adams. Of course the alley, four long blocks from Jefferson to Van Buren, gives service and pedestrian egress and ingress. Regardless of intended government/commercial uses, the average Corvallis citizen finds it deceptive and untrue to advertize a park for people, only to find it full of concrete streets and parking lots. Riverfront Park is special; it's protected by the Willamette Greenway Statute, unlike all other Corvallis area parks.

p. 11, Applicant's Response, 8-3-2000

(Footnotes)

"It is apparent that this parcel (30' S.P. ROW) could be used by the City for a variety of public uses, including a road, parking or a park."

Comment:

It will be interesting to see the outcome of the will of those voting to limit roads and parking, or not to limit; to cut, or not to cut trees.

It is also interesting to note the wording for such a pathetically tiny sliver of land, 30' wide at most: "a road, parking OR a park."

~~A note to LUBA: The current proposed land use designation~~ for this sliver of land is "Riverfront District." In it a variety of appropriate to inappropriate land uses are itemized as beginning proposals. Also included is a proposed 75' Height maximum for possible buildings, which would have shadow footprint impacts on park plantings including trees.

MARILYN DILLES
3045 N.W. Taylor
Corvallis, Or., 97330-5128
(541) 758-0062

8·23·00 10:15 am

Marilyn Dilles called concerning the letter she dropped off yesterday for the Planning Commission c/o Steve Lindsey. There is an inaccuracy in the next to last sentence on the first page - dollar amount should be $3,450,000

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Comm Dev Admin

To: The Corvallis Planning Commission
From: Tony Van Vliet, Co-Chair, Riverfront Commission

Thank you for allowing additional comments on the permit. Your committee has been extremely patient with the opponents to the permit, even though they used this opportunity more as a forum to express their general dislike for the current plan. Misuse of time and the submission of new evidence during the rebuttal period put the Commission in an ackward position.

The key question remains --Does the proposed plan meet the Willamette Greenway criteria? The answer is yes. The city staff has done a very good job of their analysis of the approved plan. I do not use the word City Plan because this was not drawn up by city staff, but by citizen panels!

Let me address several points that the opponents seemed to dwell on—more for the benefit of the press—rather than on reasoned approach.

1. During the early stages of attacking the existing plan, the bank stabilization was a key issue even though the Riverfront plan stopped at the edge of the bank. It was the CSO Project, which was concerned with stabilization. The opposition ran their forces in to virtually stop any major bank stabilization because of "unproved" new technology. Minor bank fixing under the plazas is now being challenged by "new evidence" that fungus may harm the trees near the driven rods! CH2M-Hill certainly could have used Mr.Robbins six months ago! Was this because if we really fixed the bank problem by replacing lost bank from the 1996 flood a continuous street would have fit in between Washington and B streets as in the original plan?

   So on one hand bank stabilization was linked to the Riverfront plan for purposes of publicity and last week it was detached for their statistical purposes. While you can't play on the bank the city staff correctly recognized it would be green and included it.
2. Trees—a subject that's sure to cause folks gastric juices to flow—this is a great issue to confuse the public with. You start with a large number for cutting to raise the arousal factor, but conveniently forget to mention that in the park only forty-seven scheduled for cutting are bigger than eight inches and are species in trouble—four Elm ---or twenty one Honey Locust, a non-native species. The statement was made that of the 371 new trees to be planted would be so small you would not get shade for a long time. Trees 6" in diameter and 30 ft.tall are being sold and moved today! Large trees can also be moved successfully.

Now to correct some other misstatements. Mr. Mater should exercise extreme caution when attacking the integrity of the sub-committee who worked on the concept which became the base for the current plan. He made the statement that there were only seven designs brainstormed in the 1994 Task Force Report—which is true. We added two in our deliberations. Our charge was to take that report and investigate <u>all</u> concepts that try to meet the general multiple uses envisioned in that report.

His more serious accusation was --<u>they never went back out to the public for years-the first time they worked on it wasn't until we actually got the bond issue that it was even shown to people.</u> While this had nothing to do with the permit, a correction must be made for the record.

The Sub-Committee I was asked to chair in 1995 held over twenty night meetings from August 1995 to Feb 1997. Two plans were finally taken forward for public comments in 1996-a winding road and the two way street. After many public hearings during 1996 and 1997, the two way street evolved and was presented at many public meetings.

No minutes were kept in sub-committee because much of our time was leaning over contour maps, overlays and checking specs. However, minutes were kept in all the Riverfront commission meetings where we reported our progress over the two years.

After the entire Riverfront Commission weighed all the safety issues, multiple uses, accessibility, vision statements and permit considerations, the plan was turned over to professional park designers. It was at this point a model was built for the public to view, long before we prepared for any bond measure. Mr.Mater apparently did not look closely at the model that was on display in the public library and other public events which contains a <u>two-way street and is almost identical to the current plan</u>! There was no implied deception at any time to the public!

If your Riverfront Commission would wish any changes, it would be the recommendation to continue the street all the way from Van Buren to B Street as originally planned. The reason is for police and fire protection. The Mater's convinced the council that no street should be allowed, and since 1979 have aggressively succeeded in pursuing their use of public property.

Thank you for your continued patience.

Tony Van Vliet

Somes, Judy

From: Peter Rabenold [ce@peak.org]
Sent: Tuesday, August 22, 2000 10:22 PM
To: planning@ci.corvallis.or.us
Subject: Planning Commision - Greenway/Riverfront

Corvallis Planning Commission:
I would like to submit my concerns regarding the city's application to build
in the Willamette Greenway portion of the Riverfront Park. I find it highly
objectionable that the city wishes to remove many large existing trees and
generally 'start from scratch' in landscaping the parking lot/road/pathway
system that they contend is a park. It seems absurd to say that the Greenway
is improved by removing mature trees and adding pavement to the extent
that the city plans propose. I find the assertion that more trees will be the end
result to be highly unsatisfying - one can say the same thing about a recently replanted
clear cut but all those saplings do not provide shade, bird habitat or any or
the many values that come from a mature tree. While some of the individual
trees in the existing park are problematic, many others are fine and should be
incorporated into any plan for the Greenway.

In addition, I find the amount of pavement that the city wants to put within the
Greenway totally appalling. I think Corvallis has used up its allotment of paving
over the river's edge - the acreage of asphalt laid down at the Crystal Lake boat
launch/soccer field area is huge. It seems like it should be forbidden to pave
within one tree trunk's width of the river's edge, which is what they have done.
Please do not allow more impervious surfaces to be applied to the riverfront within
the Willamette River Greenway. All measures of riverine health indicate that less
impervious surface, the healthier the aquatic system and that should be a prime
consideration in this deliberation.

Please protect the GREEN in the Willamette Greenway and do not allow
more roads, sidewalks and other developments to be constructed within
this finite and precious edge of ground.
Sincerely,
P. K. Haggerty
Corvallis, OR
ce@peak.org

Somes, Judy

From: John Wolcott [johnwolcott@mail.com]
Sent: Friday, August 18, 2000 10:39 AM
To: planning@ci.corvallis.or.us
Subject: Greenway Hearing

18 August 2000
To: Planning Commission
Re: Greenway Permit

I have the following concerns about the permit currently being requested by
the City of Corvallis for riverfront construction:

1. I understand that the Greenway regulations require that every effort be
made to preserve, not replace, existing trees. I do not believe this has
been done.

2. I attended a presentation in which people, said to be experts on the
subject, stated that the cement pilings called for in the City's plan were
not needed for stabilization of the existing bank, but rather for the
increased construction the City plans to add beyond the geo-stability line.
I believe the addition of such pilings for this purpose to be contrary to
the intent of the Greenway regulations.

3. Due to extensive public opposition to the City's plan, City
representatives have publicly discouraged voters from signing an initiative
to change this plan, attempted to keep this initiative off the ballot once
signatures were obtained, and said they would obstruct the initiative if it
were passed. In this atmosphere, I believe it will be difficult for the
Planning Commission, which is appointed by the City, to produce an objective
conclusion concerning the above two, and other possible objections. Perhaps
some outside opinion should be sought on whether, or to what extent, this
request conforms to the Greenway regulations.

John Wolcott
342 N.W. 29th St.
Corvallis OR 97330
752-4451

Mater
Investment
Company P.O. Box 0 • 101 S.W. Western Blvd. • Corvallis, Oregon 97333
(503) 753-7335

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Date: August 15, 2000

To: Planning Commission
City of Corvallis

From: M. Scott Mater, Managing Partner
Mater Investment Company

Subject: **WRG00-00002: Riverfront Commemorative Park and Bank Stabilization Willamette River Greenway Conditional Development Permit Continued Riverfront Hearing, August 16, 2000**

The amount of new information that was provided by the Applicant was so voluminous and significant that new original testimony should have been allowed, as requested, during the continued hearing. Requiring testimony on this new material in rebuttal not only violates the rebuttal rules of the Planning Commission but also violates the spirit of debate.

Due to time limitations imposed on Public input during the hearing and the amount of new material put forth by the applicant and proponents of the Permit, I was not able to fully cover my testimony on this matter during the hearing. The following is a summary of my key testimony on this issue:

Comments on Applicant's and Staff's Supplemental Report

The applicants supplemental report included a number of misstatements and incomplete information as with the original application, including:

1. **Compliance with the Comprehensive Plan** – The applicant continually referred to the Comprehensive Plan as a justification for the project. This is a form of "circular logic"; the Council wrote the comprehensive plan based on the riverfront plan that they also approved. Now they justify the riverfront plan because it is what is in the Comprehensive Plan.

2. **P2., The authors of the report owes many opponents apology. Most who testified** were not representing the Friends of the Riverfront. Some are not even members. I was clearly representing Mater Investment Company and my family. They also owe the Planning Commission an apology for insinuating that you shouldn't be concerned about the arguments against the project because they have been discussed by other parties. This is the first public process to specifically address the City's Road plan from the perspective of the Willamette River Green Way. The Planning Commission may be the last chance to get the river back into the Riverfront Park.

3. **Item 2.; Floodplain impacts; (see previous letter dated August 15, 2000)**

    a. New analysis doesn't take into account North Parking lot fill. They have not provided you with a revised analysis as of the hearing date.
    b. Doesn't account for revisions to revegetation plan which will significantly change previous calculations.
    c. Not providing this information and analysis is a clear violation of LDC 3.30.40.e and LDC 3.30.50.a.4
    d. This a also a violation of Comprehensive Plan Policy 3.6.1 – Land designated as flood plain shall be urbanized only in accordance with an adopted flood plain management program. The Applicant has failed to show how there urbanization complies with any adopted management flood plain plan.

    Recommended Action: Prior to making a decision on the Greenway Permit, require the Applicant to provide a full analysis on the cut and fill involved in the North and South Parking lots and to provide a new analysis on the bank work impacts on the floodway. Eliminate the section of fill for the road from Western to "B" Street.

4. **Item 3; Trees;** The applicant often stated that this plan was one of compromises and they won't even move a sidewalk or provide cutouts for significant trees. They obviously weren't interested in preserving anything which wasn't engineered in the plan. No attempt was made to work around existing trees and memorials which might interfere with their straight line, sanitized, concrete park.

    P. 6. Closure of First Street was not a concession to the property owner; it was a concession to Mother Nature. Most Council persons who voted to close this section cited the 1996 slide as the primary reason, check the minutes.

    It is also a 15 ft wide sidewalk with planting strip and curb, not 10 ft. as stated. Why is a concrete planting strip needed for trees next to a park?

    Recommended Action: Require Applicant to modify the design, where possible, putting a higher priority on saving trees and memorials than straight lines of concrete. In the Western to Washington block, provide a narrower, lighted sidewalk with meanders or cut outs as required to preserve existing landscaping and memorials. Eliminate the curb and planting strip shown in the drawings.

5. Memorials

    While we appreciate the mention, the Graffiti Wall is not a memorial, on City property or by any means a result of efforts by the City. However, the new sidewalk will interfere with the use of this piece of private property contrary to LDC 3.34.40.g.

Challenger Memorial – The benches and 2 trees are missing because the City took them out as part of the CSO construction and never replaced them. The memorial, designed by Park and Recreation Staff, included benches for quiet reflection. Flowering deciduous trees were used to provide rebirth in the Spring Shade in the Summer and color in the Fall and openness to limited light in the Winter. The seven conifers proposed will provide an overbearing permanently shaded dark area in the park.

Mater Memorial – This memorial was built by the youth work program of the Community Services Consortium, supervised and designed by Parks and Recreation, with money donated by Jean Mater. Martin Luther King would probably not be happy to know he wasn't a private citizen and that people would be directed to "the other side of the river" to visit his memorial grove.

Recommended Action: Require Applicant to modify the design, putting a higher priority on saving memorials, in location and concept, than straight lines of concrete. Modify the multi-modal path alignment to preserve the MLK Memorial Grove, as is. In the Western to Washington block, provide a narrower, lighted sidewalk with meanders or cut outs as required to preserve existing memorials. Restore the Challenger Memorial benches and replace the two missing trees with large, similar trees.

6. Separation from River

Look at Staff's and the Applicant's own numbers. The application clearly violates LDC 3.30.50.c. for more than 50% of the riverfront under consideration.

For 50% of the river frontage in under consideration, in the narrowest portion of the public land on the riverfront, the most visible from the river, with the greatest impact on the river, the applicant proposes to:

- decrease open space,
- increase pavement (pave more than 80% from bank to building on 2 of the blocks)
- put fill in the floodplain
- remove significant trees
- and increase odor and noise (Staff Report P.3)

For this, we are going to provide NO parking for 4 blocks and a street without access to properties. I haven't found any language in the ordinances that says you can make up for violations of greenway standards in one place by improvements in another. This isn't a wetland or floodplain type of choice.

Recommended Action: Require Applicant to modify the design, putting a higher priority on open space than straight lines of concrete. In the Washington to Jefferson blocks, provide a narrower, lighted sidewalk and a narrower one-way road. Maintain all significant construction behind the Geotechnical

Stability Line. Require Applicant to provide a minimum of 35% green space from top of bank to edge of property lines in these blocks.

7. **First Street Location and Design**

a. The applicant again brought up the issue of 20 ft. street requirement from the UBC. All I can say is either this is not the case or City Hall is in violation. Look at picture.

b. Missed point of testimony on parking. The issue was the statement in the application that;

"Diagonal rather than 90 degree parking is more efficient"

This is not correct: The road width in this area is the same as North of Van Buren. It doesn't take an engineer to see that you can get more parking for the same amount of pavement using 90 degree over 60 degree. If your going to waste this much of our park in pavement, you should at least make it the most efficient use possible. Other benefits of 90 degree parking include:

- you can park on either side
- better backing visibility
- safer for bicycles
- slows traffic

As presented in the application, a motorist traveling on 1st Street North from Washington would travel 4 blocks (2/3 of the road) before being presented with an opportunity to park. If they couldn't find a parking space in the next two blocks, they would be faced with crossing VanBuren and some how getting turned around to try to find a space in 3-1/2 blocks going South. Not exactly efficient or good access for businesses in the area.

Recommended Action: Require Applicant to modify the design to use 90 degree parking instead of 60 degree to live up to their own statements about efficiency. Modify application to use one-way streets in narrow sections of the riverfront where 30% open space cannot be achieved with 2-way streets. Eliminate through street between Washington and Adams.

8. **Railroad Right-of-Way, B to Western**

This land was not purchased for West side bypass as stated. It was purchased as an over all land consolidation when the East side bypass was constructed in the late 1980's. All the land not used for that bypass has been used as a park since the completion of the work. It has never been used as a road.

Recommended Action: Require Applicant to eliminate the through road from Western to "B" Street. The parking can be redesigned to service the Park area without the through road.

9. Staff Report – Closure of First Street between Wash. and Western

If you amend a Greenway Permit, as you are considering now, wouldn't you consider any conditions placed on the development a part of the Conditional Use Permit?

In August 4, 1980, the City Council (attached as part of the Staff Report) amended our greenway permit and included as the 6th condition:

> " The closure of 1st street shall be done in a manner meeting the approval of the City Engineer."

This was made as a condition of our approval for our office building.

Again all landscaping of the closed road area was done according to our Greenway Conditional Use Permit as required by the City. Under the City's LDC, a conditional use permit cannot be amended without the appropriate public process which includes, application, advertising of the specific amendment and appropriate notification. This has not been done.

Recommended Action: Require Applicant to modify the design in the Western to Washington block to provide a narrower, lighted sidewalk with meanders or cut outs as required to preserve existing landscaping.

10. Other Testimony

In the interest of brevity, I will not repeat all the other objections we have to the Application as most of them were raised by others who spoke in opposition. Please consider these other objections presented as incorporated into our testimony.

Thank you for considering this testimony. I believe that the misstatements and omissions in the Applicant's request are significant enough that you will require they provide you with the correct information before making a decision on this issue. It is too important to rush for expedience sake. A few more weeks won't matter for this important a decision. This may be the last chance for the Road Plan to be considered from the River's perspective.

Planning commission citizen comment on Riverfront Commemorative Park and Riverbank Ecological Restoration Plan

James Robbins 8-~~16~~-2000 22

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Review Criteria – Applicable Comprehensive Plan Policies

LDC 3.30.50 – Willamette River Greenway Development Standards, Subsection (3)
Stability shall be assured considering the stress imposed on the bank and land area between the low water mark of the river and top of the bank.

Placement of piles and micro-piles on top of, or West of the slope line, will not significantly stabilize the bank between the riverbank and the top of the slope!

The response by the city "Figure 7 shows the location of proposed shear pile and micro-pile walls that will stabilize the escarpment above the Willamette River while allowing retention of virtually all existing trees within the Riverbank area" is not scientifically valid.

The engineering theory of the influence of piles in stabilizing slopes is covered in the attached article by Hassiotis et al. "Design Method for Stabilization of Slopes with Piles" in the Journal of Geotechnical and Geoenvironmental Engineering, Pp314-323, April 1997. Results of the analysis model as applied to steep slopes similar to those of the Corvallis riverfront (but with 50% higher effective cohesion @498 PSF), is shown in Figure 6 on page 318. This Figure illustrates that the FACTOR OF SAFETY increases (dotted line) until the pile placement point reaches a position approximately three-fourths (3/4) up the slope. As piling placement approaches the top of the slope the corresponding FACTOR OF SAFETY decreases to a minimal value at approximately the top of the slope. This conclusion is reiterated in point #2 of the conclusion section on page 322; which states: "For a maximum factor of safety, the piles must be placed in the upper middle part of the slope. Generally, they must be located closer to the top of the steeper slopes than the shallower ones." [Footnote: it is assumed that the pile and micro-pile groups are end-bearing piles and not friction piles]

This engineering analysis model shows that the City's application does not meet Review Criteria *LDC 3.30.50.3*

Section 3.4.3 Identify geotechnical hazards and and related bioengineering considerations under Section 5.1.2.F Protect and enhance riparian vegetation

(1) My previous comment #7 (8-16-2000) suggesting a translational failure may have been overstated. The three models that could have applied to this slope failure are:

(1) translational failures using an infinite slope model;
(2) limited slope:simple wedge; or
(3) limited slope circular arc (method of slices).

From evidence of sidecasting (Figure 6, in "A Restoration/Enhancement Plan for the Corvallis Riverfront") the simple wedge failure with a tension crack at the upper failure surface may be a better model. However, there doesn't seem to be adequate evidence to definitively state which type of ideal failure actually occurred.

From a modelling standpoint the limited slope circular arc model calculates a factor of safety that can be applied to risks to people and infrastructure. When considering the stability of the riparian zone slope the infinite slope or limited slope/simple wedge models incorporating bioengineering factors can be used to predict failures. In any case, the chosen model may fail when the assumptions of the model filter out complex geomorphic surfaces and corresponding hydrologic flow within the slope.

(2) The use of staggered micro-piles near large trees will probably be less of an impact on tree roots than the piles. This does not eliminate the potential for pathogens entering damaged root surfaces and resulting in the death of the tree in question. It is recommended that the City follow up on the suggestion that an OSU plant pathologist be consulted to determine if such a disease potential is a legitimate concern for the big leaf maples that dominate the slopes in question.

(3) The city should also recognize that big leaf maples only survive on this slope due to a symbiotic relationship between the tree root and endomycorrhizal fungi that provide a pseudo root hair mat near growing root surfaces. Such fungal hairs dramatically improve the tree's water uptake from fine pores in the dry season when there is a high negative water potential (kPa). Excavating to install infrastructure involves cutting back the root mat from mature trees, dramatically reducing the water availability for several years. This induced drought has the effect of weakening the tree, thus making it more susceptible to disease.

James Robbins
8-23-2000

Design Method for Stabilization of Slopes with Piles

By S. Hassiotis,[1] J. L. Chameau,[2] and M. Gunaratne[3]

Abstract: A methodology is proposed for the design of slopes reinforced with a single row of piles. An existing method which is based on the theory of plasticity is used to find the lateral forces acting on the pile section above the critical surface. A portion of that force is assumed to be mobilized against the movement of the slope. Then, the friction circle method is extended to incorporate the reaction force in the stability analysis. Thus a new stability number that includes the pile reaction is used to determine the modified critical surface and safety factor of the reinforced slope. Finally, a procedure is proposed to achieve an optimum design solution which provides a desirable factor of safety for the slope/pile system.

INTRODUCTION

Landslides often result in extensive property damage and sometimes loss of human life. Insuring the stability of both, natural and man-made slopes continues to be a fundamental problem in geotechnical engineering.

Avoidance of a potential slide area can be a primary consideration when selecting a new site. Otherwise, corrective measures must be taken which include improving the slope geometry, or providing surface and subsurface drainage. Retaining structures may be necessary where corrective measures fail to insure stability, or when their use is prohibited due to space limitations. The use of piles as a retaining element has been applied successfully in the past and proved to be an efficient solution, since piles can often be easily installed without disturbing the equilibrium of the slope (DeBeer and Wallays 1970; D'Appolonia et al. 1977; Ito et al. 1981; Nethero 1982).

The analysis of a slope reinforced with piles requires that the force applied to the piles by the failing mass, and as a result the reaction from the piles to the slope, be known. In addition, a modified slope stability analysis that takes into account the reaction force is necessary. In the research reported herein, these issues are addressed and a methodology is developed for the analysis and design of the slope/pile system. First, the lateral forces induced by the failing slope on a row of piles are estimated based on a method developed by Ito and Matsui (1975). A portion of this force is assumed to be mobilized against the movement of the slope. Then, following Taylor's method of stability analysis, a new stability number is derived to account for the presence of the piles and their effect on the location of the failure surface. After the new failure surface is calculated, the piles can be designed to structural specifications. The critical parameters that affect the stability of a pile-reinforced slope are shown to include the pile diameter, spacing, and location upslope. A step-by-step procedure is introduced for the simultaneous design of the slope and the piles to meet safety criteria.

FORCES ON PILES IN SOIL UNDERGOING LATERAL MOVEMENT

The problem of active piles (piles subjected to a horizontal load at the head and transmitting this load to the soil) has been treated by several authors (Poulos 1973; Coyle et al. 1983). In most cases the problem of a single pile has been solved, and some correction factors for group effects have been introduced.

For the case of passive piles, the problem is more complicated because the lateral forces acting on the piles are now dependent on the soil movements, which are in turn affected by the presence of piles. Hence, the solution for a single pile cannot be easily adapted for the situation of a pile group, although several authors have suggested such an approach (Poulos 1973; Viggiani 1981). Other researchers have considered the problem from the fundamental standpoint of group (row) action. Winter et al. (1983) considered the solution of piles placed in a row, taking into account the spacing between the piles at the beginning of the analysis. However, the method can only be used in purely cohesive slopes undergoing cre Ito and Matsui (1975) have proposed a theoretical methoc analyze the growth mechanism of lateral forces acting on stabilizing piles when the soil is forced to squeeze between piles. The method was developed to specifically calculate pressures that act on passive piles in a row, and was chosen in the present work. The force that the failing mass exerts on a row of piles can be expressed as a function of the soil strength, the pile diameter, spacing, and location. Assuming that a portion of that force is counteracting the driving forces of the slope, the safety factor of the slope after the placement of piles can be calculated as a function of pile size and position.

It is assumed that piles placed in plastically deforming ground can prevent further plastic deformations. In order to design the piles, the lateral forces need to be estimated as accurately as possible. These forces, however, are a function of the movement of the sliding mass. They may vary from zero, in case of no movement, to an ultimate value, in case of large movements. The theory developed by Ito and Matsui (1975) estimates a value for the lateral force between these two extremes, assuming that no reduction in the shear resistance along the sliding surface has taken place due to strain-softening caused by the movement of the landslide. For that reason, only the soil around the piles is assumed to be in a state of plastic equilibrium, satisfying the Mohr-Coulomb yield criterion. Then, the lateral load acting on the piles can be estimated regardless of the state of equilibrium of the slope. Inherent in this approach is the assumption that the soil is soft and able to plastically deform around the piles. The theory of plastic deformation is based on the following additional -- sumptions.

1. When the soil layer deforms, two sliding surfaces, AEB and $A'E'B'$, occur making an angle of $[(\pi/4) + (\phi/2)]$ with the x-axis (Fig. 1).
2. The soil is in a state of pl area $AEBB'E'A'$ where the rion applies

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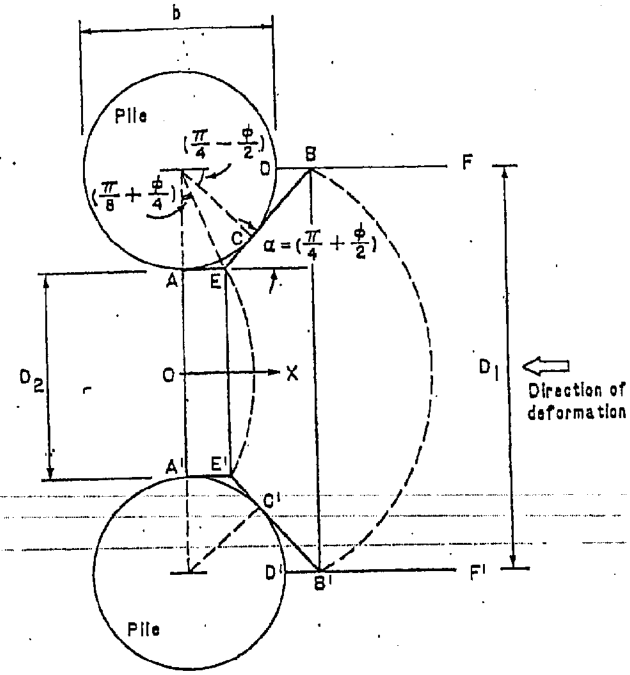


FIG. 1. Plastically Deforming Ground around Stabilizing Piles [after Ito and Matsui (1975)]

4. Plane strain conditions exist with respect to depth
5. The piles are rigid
6. The frictional forces on surfaces AEB and $A'E'B'$ are neglected when the stress distribution in the soil $AEBB'E'A'$ is considered.

The state of stress in zones $EBB'E'$ and $AEE'A'$ can be found assuming the Mohr-Coulomb yield criterion governs the plastic deformation. The lateral force per unit thickness of layer acting on the pile, q, has been shown to be

$$q = A_c\left(\frac{1}{N_\phi \tan\phi}\left\{\exp\left[\frac{D_1 - D_2}{D_2} N_\phi \tan\phi \tan\left(\frac{\pi}{8}+\frac{\phi}{4}\right)\right]\right.\right.$$
$$\left.\left. -2N_\phi^{(1/2)}\tan\phi - 1\right\} + \frac{2\tan\phi + 2N_\phi^{(1/2)} + N^{-(1/2)}}{N_\phi^{(1/2)}\tan\phi + N_\phi - 1}\right)$$
$$- c\left(D_1\frac{2\tan\phi + 2N_\phi^{(1/2)} + N_\phi^{-(1/2)}}{N_\phi^{(1/2)}\tan\phi + N_\phi - 1} - 2D_2 N_\phi^{-(1/2)}\right)$$
$$+ \frac{\gamma\bar{z}}{N_\phi}\left\{A\exp\left[\frac{D_1 - D_2}{D_2} N_\phi \tan\phi \tan\left(\frac{\pi}{8}+\frac{\phi}{4}\right)\right] - D_2\right\} \quad (1)$$

where c = cohesion intercept; D_1 = center-to-center distance between piles; D_2 = opening between piles; ϕ = angle of internal friction of soil; γ = unit weight of soil; $\bar{z}$ = depth from ground surface; $N_\phi = \tan^2[(\pi/4) + (\phi/2)]$ and $A = D_1(D_1/D_2)^{[N_\phi^{(1/2)}\tan\phi + N_\phi - 1]}$.

The total lateral force acting on a stabilizing pile due to the plastically deforming layer around the pile, F_n is obtained by integrating (1) along the depth of the soil layer. Although (1) is developed for rigid piles, it may be extended to flexible piles since only the ground deformation just around the pile is taken into consideration. Such deformation can be assumed to exist even if the pile experiences deflection (Ito et al. 1981). A series of field and model tests were performed to show that the theory can be used to predict closely the forces on piles embedded in deforming soil (Ito et al. 1982). The closest agreement was

Ito et al. (1981) developed a design methodology for a pile-reinforced slope considering a fixed failure surface. They also recommended the use of the ordinary method of slices to estimate the safety factor. However, since the critical surface invariably changes due to addition of piles, the above method is limited in its application.

SAFETY FACTOR OF STABILIZED SLOPE

The stability of a slope can be investigated by a number of limit equilibrium methods, including the friction circle method, and the method of slices. Of these, the friction circle method was found to be the most convenient to analyze pile-reinforced, homogeneous slopes.

The limit equilibrium calculations are based on an assumed shape of a rupture surface. The safety factor, FS, is defined as the ratio of the shear strength available to the shear strength required to maintain the slope in a state of limit equilibrium. Assuming the Mohr-Coulomb failure criterion, the factor of safety is given by

$$FS = \frac{c_a + \sigma_n \tan\phi_a}{c_r + \sigma_n \tan\phi_r} \quad (2)$$

where subscripts denote available and required quantities; anc σ_n = normal force acting on surface of rupture.

As an aid in determining FS, the factors of safety with re spect to cohesion, F_c, and friction, F_ϕ, have been used in th past, where

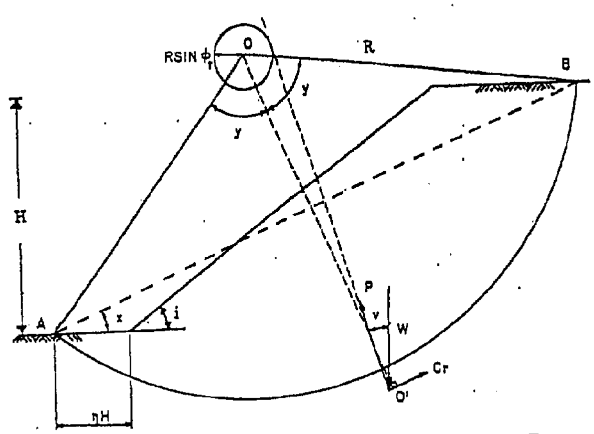
$$F_c = \frac{c_a}{c_r} \text{ and } F_\phi = \frac{\tan\phi_a}{\tan\phi_r} \quad (3$$

The true safety factor, FS, is obtained when F_c and F_ϕ are equal

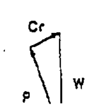
$$FS = F_c = F_\phi \quad (4$$

The parameters of the friction circle method used for the anal ysis of homogeneous slopes are shown in Fig. 2 (Taylor 1937) The forces that act on the mass are the weight, W, the cohesion force required to maintain equilibrium, C_r, and the resultant o the normal and frictional forces, P. The force P is almost tangen to a circle of radius $R \sin\phi_r$ as shown in Fig. 2.

The following two expressions for the stability number wer



$OO' = R\frac{AB}{AB}$



derived by Taylor (1937) for a toe failure and a base failure, respectively:

$$\frac{c_a}{F_c\gamma H} = \frac{(1/2)\ \csc^2 x(y \csc^2 y - \cot y) + \cot x - \cot i}{2 \cot x \cot v + 2} \tag{5}$$

and

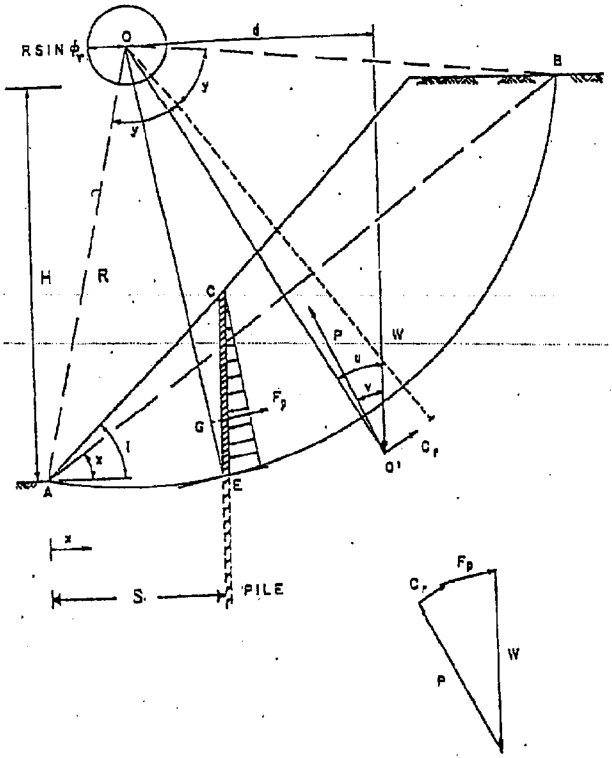


FIG. 3. Forces on Slope Reinforced with Piles

$$\frac{c_a}{F_c\gamma H} = \frac{(1/2)\csc^2 x(y \csc^2 y - \cot y) + \cot x - \cot i - 2\eta}{2 \cot x \cot v + 2} \tag{6}$$

where x, y, and v = angles indicated in Fig. 2; while i and H = inclination angle and height of slope, respectively. Further, η = ratio of distance between toe of slope and point A to top of slope.

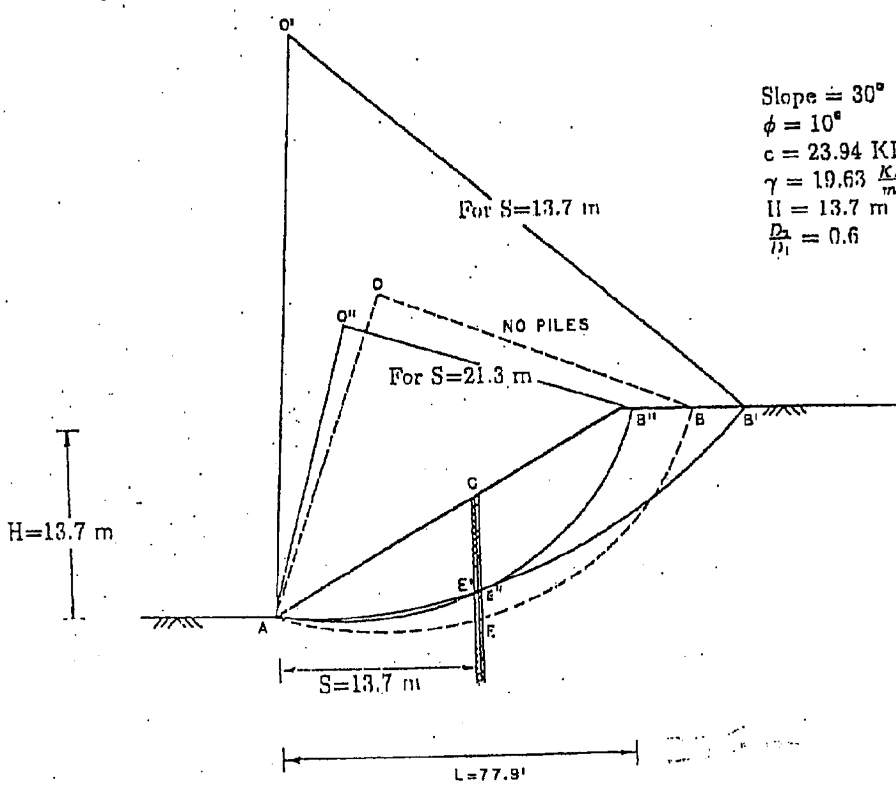
The safety factor with respect to cohesion, F_c, can be obtained for any surface defined by angles x and y by using (5) and (6) and an assumed F_ϕ. It is realized from Fig. 2 that v depends on ϕ_r, which can be estimated from the assumed F_ϕ using (4) and the known ϕ_a of the soil. The true safety factor of any assumed surface is obtained through successive iterations of (5) or (6), until F_c is equal to the assumed F_ϕ. The critical surface is the one for which the factor of safety is minimized. This minimum value is the safety factor of the slope.

When a row of piles is inserted in the slope, the additional resistance provided by the piles changes both the safety factor and the critical surface. The new slope to be analyzed is shown in Fig. 3. The forces applied on the slope are identical to the ones in Fig. 2, with the exception of the force exerted on the slope by the piles, F_p. To obtain this force per unit width of the sliding mass, (1) is integrated along the depth of the pile in the failure wedge and the result, (F_t), is divided by the center-to-center distance between the piles, D_1 (i.e., $F_p = F_t/D_1$).

The resistance force, F_p can be incorporated in the force polygon (Fig. 3) resulting in two new expressions for the stability number for a toe failure and a base failure, respectively (Hassiotis and Chameau 1984)

$$\frac{c_a}{F_c\gamma H} = \frac{E - \dfrac{12F_p}{\gamma H^3}\left[\dfrac{\cos(CEO)}{\sin v}\dfrac{H}{2}\csc x \csc y \sin\phi + OG\right]}{6 \csc^2 x \csc y \sin\phi\left[\dfrac{\cos x}{\sin v} + \csc(u - v)\cos(x - v)\right]} \tag{7}$$

and



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$$\frac{c_a}{F_c\gamma H} = \frac{(E + 6\eta^2 - 6\eta \sin\phi \csc x \csc y) - \dfrac{12F_p}{\gamma H^3}A}{6\csc^2 x \csc y \sin\phi \left[\dfrac{\cos x}{\sin v} + \csc(u - v)\cos(x - v)\right]} \tag{8}$$

where

$$E = 1 - 2(\cot^2 i + 3 \cot i \cot x - 3 \cot i \cot y + 3 \cot x \cot y)$$

where CEO = angle F_p forms with horizontal; OG = moment arm of F_p; and u = angle indicated in Fig. 3. Eqs. (7) and (8) can be used in the same manner as (5) and (6) to obtain the safety factor for the slope. The three additional parameters are the magnitude, direction, and line of action of the force F_p. Of these, the direction of F_p is assumed to be parallel to the failure surface at the point of intersection of that surface with the piles.

Every time a new surface is selected, the length of the pile above the failure surface (CE) changes and, consequently, the magnitude of the force F_p changes (Fig. 3). To take this into account, the length CE was expressed as a function of the ϕ-circle parameters, x and y, and the location of the pile with respect to the toe of the slope, S (Hassiotis and Chameau 1984). Thus, every time a new failure surface is chosen, a new pile length, and thus a new F_p, is calculated. This force is then used in (7) and (8) to determine a new stability number.

When piles are inserted in the slope, the location of the critical surface changes since an additional force, F_p, is introduced in the limit equilibrium equations. This is illustrated in Fig. 4 for a slope of height 13.7 m and angle 30° with material properties c, ϕ, and γ equal to 23.94 KPa, 10°, and 19.63 KN/m^3, respectively. The original factor of safety of the slope (without the pile reinforcement) was 1.08, obtained for the critical surface OAB. After insertion of a row of piles with diameter ratio D_2/D_1 of 0.6, placed 13.7 m upslope, the factor of safety increased to 1.82 and the critical surface changed to $O'AB'$. Insertion of piles 23.1 m upslope yields a factor of safety of 1.64 and the critical surface of $O''AB''$. The assumption that the critical surface does not change with the addition of the piles would lead to non-conservative answers for the factor of safety.

The influence of the location of the piles, S, on the factor of safety of the above slope is shown in Fig. 5. For each value of S, the safety factor was computed for both, the original critical surface (solid curve), and the modified critical surface which was found after the addition of piles of a given ratio D_2/D_1 (dashed line). For the modified critical surface, the reaction force F_p is smaller and hence, the actual factor of safety is less than the one computed for the original surface.

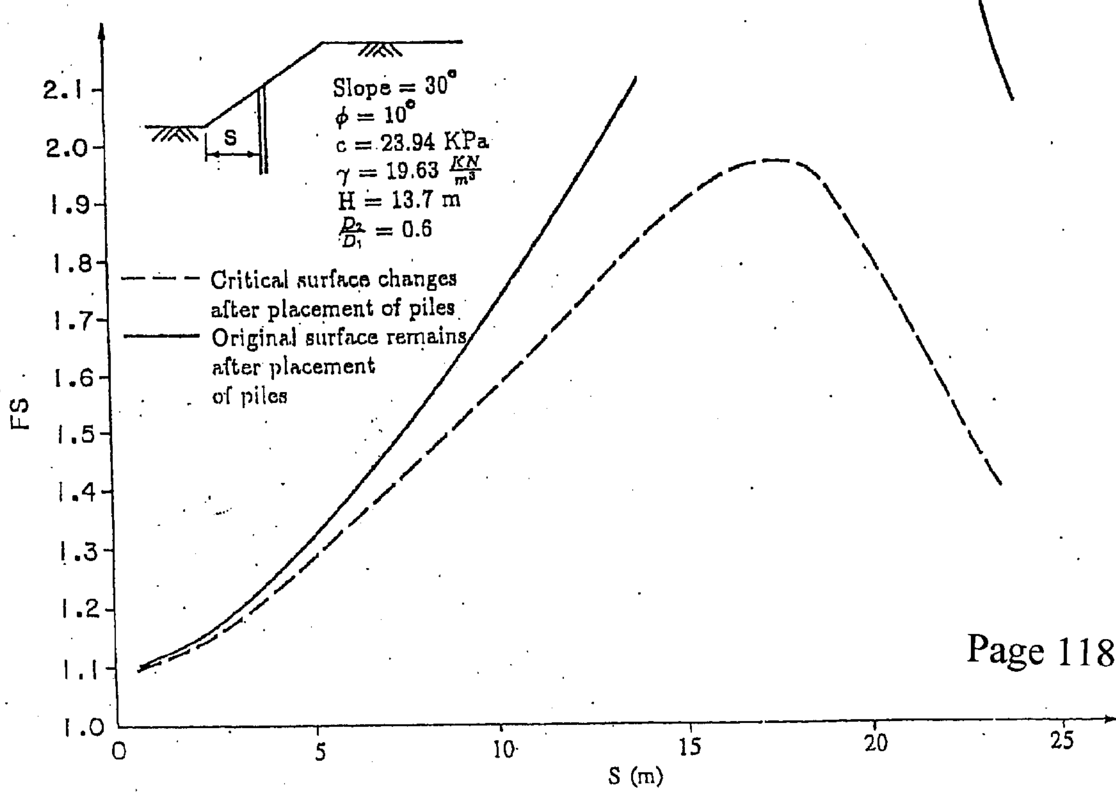
The behavior of the safety factor of a steep slope reinforced with piles is shown in Fig. 6. The critical surfaces of a steep slope remain deep and the factor of safety increases with S until the piles are placed close to the top of the slope. Evidently, the piles need to be placed closer to the top of a steep slope than that of a shallow slope for maximum factor of safety to be achieved.

An overestimation of the force F_p can lead to nonconservative results in the design of the slope. A more practical approach for design is to introduce the notion of a mobilized lateral force. According to the assumptions made by Ito and Matsui (1975), the force acting on the slope is equal to F regardless of the state of equilibrium of the slope. Based on that assumption, the stability number can be expressed as

$$c_a/F_c\gamma H = f(F_p) \tag{9}$$

It is suggested herein that a mobilized lateral force, F_m, be used where

$$F_m = \frac{F_p}{a} \tag{10}$$



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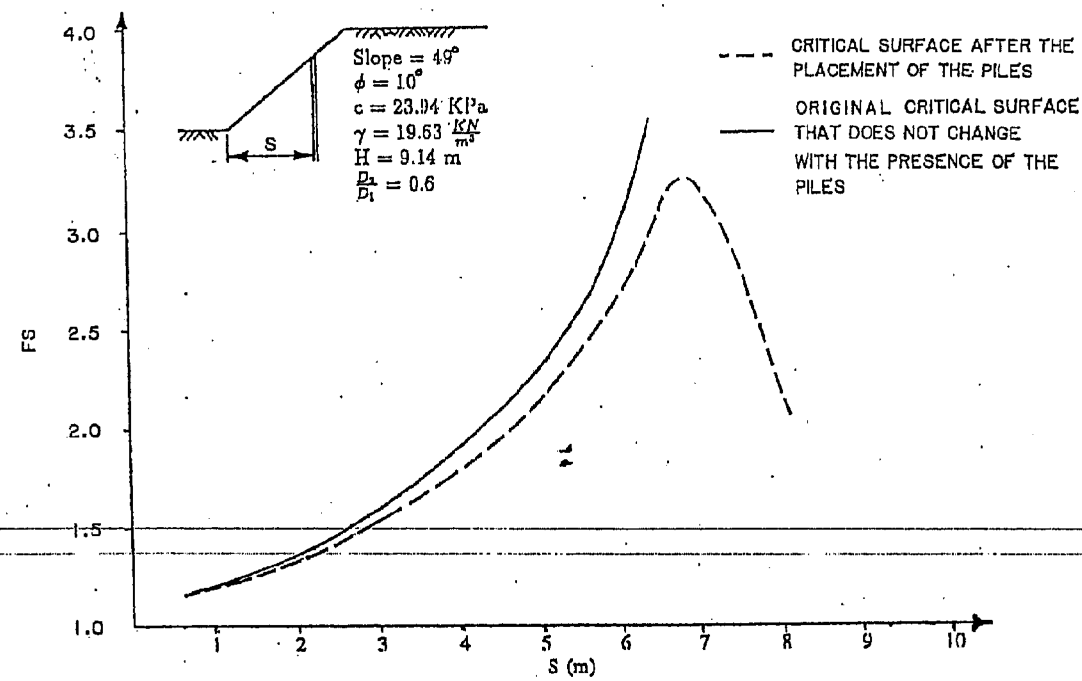

FIG. 6. Effect of Pile Location on Factor of Safety of Steep Slope

with a being greater than 1.0. The mobilized force is used to analyze the slope, but the total force per unit length may be used to design the piles. This results in a conservative design for both, the piles and the slope.

In addition, it is proposed that the force F_p be scaled by the factor of safety with respect to cohesion of the reinforced slope (i.e., $a = F_c$). The resulting stability number is

$$c_a/F_c\gamma H = f(F_p/F_c) \qquad (11)$$

This implicit equation for F_c can be solved by iteration, until F_c is equal to F_ϕ. Thus, the mobilized pile force is reduced depending upon the safety factor. Practically, this implies that F_m will be equal to F_p for a slope at the point of incipient failure, but will decrease as the degree of stability of the slope increases. The critical surface determined by using the modified force falls between the critical surface obtained without the piles, and the one obtained with the piles providing a fully mobilized force. The curve relating the factor of safety to the distance S has a shape similar to the previous curves (Figs. 5 and 6). However, the rate of increase of FS with S is less than that for a fully mobilized force, and the peak value is not as sensitive to S as before.

DESIGN OF LATERALLY LOADED PILES

In designing piles to resist lateral loads, the profiles of deflection, bending moment and shear force along the piles are required. It is convenient to consider the governing equation for the pile deflection in separate forms for the pile segments above and below the failure surface.

A closed form solution of the beam equation is used to analyze the pile section which extends above the critical surface (Fig. 7)

$$EI(d^4y_1/dz^4) = q(z), \quad (-CE \le z \le 0) \qquad (12)$$

where y_1 = pile deflection above sliding surface; and EI = stiffness of pile. The force intensity, $q(z)$, is calculated using the principle of plastic deformation of soil and is given by

$$\ldots \qquad (13)$$

where q_1 and q_2 are obtained from the linear distribution of $q(z)$ found in (1). A closed form solution of (12) can be readily available by direct integration.

A finite difference method is used to analyze the pile secti[on] which is embedded below the critical surface as a beam on an elastic foundation, the deflection of which is governed by

$$EI(d^4y_2/dz^4) = -Ky_2(z \ge 0) \qquad (14)$$

where y_2 = pile deflection below sliding surface. The elastic constant K is related to the modulus of subgrade reaction for soil by $K = bK_s$ or for rock by $K = bK_r$, where b = pile diameter. A finite difference scheme was chosen to solve (14), to allow for variations of the elastic constant with depth.

NUMERICAL ILLUSTRATION OF SLOPE AND PILE DESIGN PROCEDURE

Effective stabilization of a slope with piles requires not only that the stability of the slope be assured, but also that the piles be adequately designed. Here, the parameters that affect the stability of the slope and the design of the piles are analyzed. A step-by-step procedure is outlined to select these parameters and achieve an efficient stabilization scheme. A typical application is given for the stabilization of the shallow slope shown in Fig. 8. The factor of safety of the slope and the displacement, moment, and shear profiles along the piles are calculated by using the methodologies discussed in the preceding section. Finally, a structural design example is provided to illustrate how various factors can be modified to achieve an optimum design.

The slope in Fig. 8 has a height of 13.7 m, a slope angle of 30°, and is made of a homogeneous material with a fricti[on] angle, ϕ, of 10°, cohesion, c, of 23.94 KPa, and unit wei[ght], γ, of 19.63 (KN/m³). The critical surface of the unreinforce[d] slope, shown by a dashed line, corresponds to a minimum safety factor of 1.08. The distance from the ground surface to the critical surface at pile location (CE), is 5.8 m. Since a factor of safety of 1.08 is inadequate, it is recommended that the slope be reinforced with a r[…] steps are proposed to achieve an e[…]

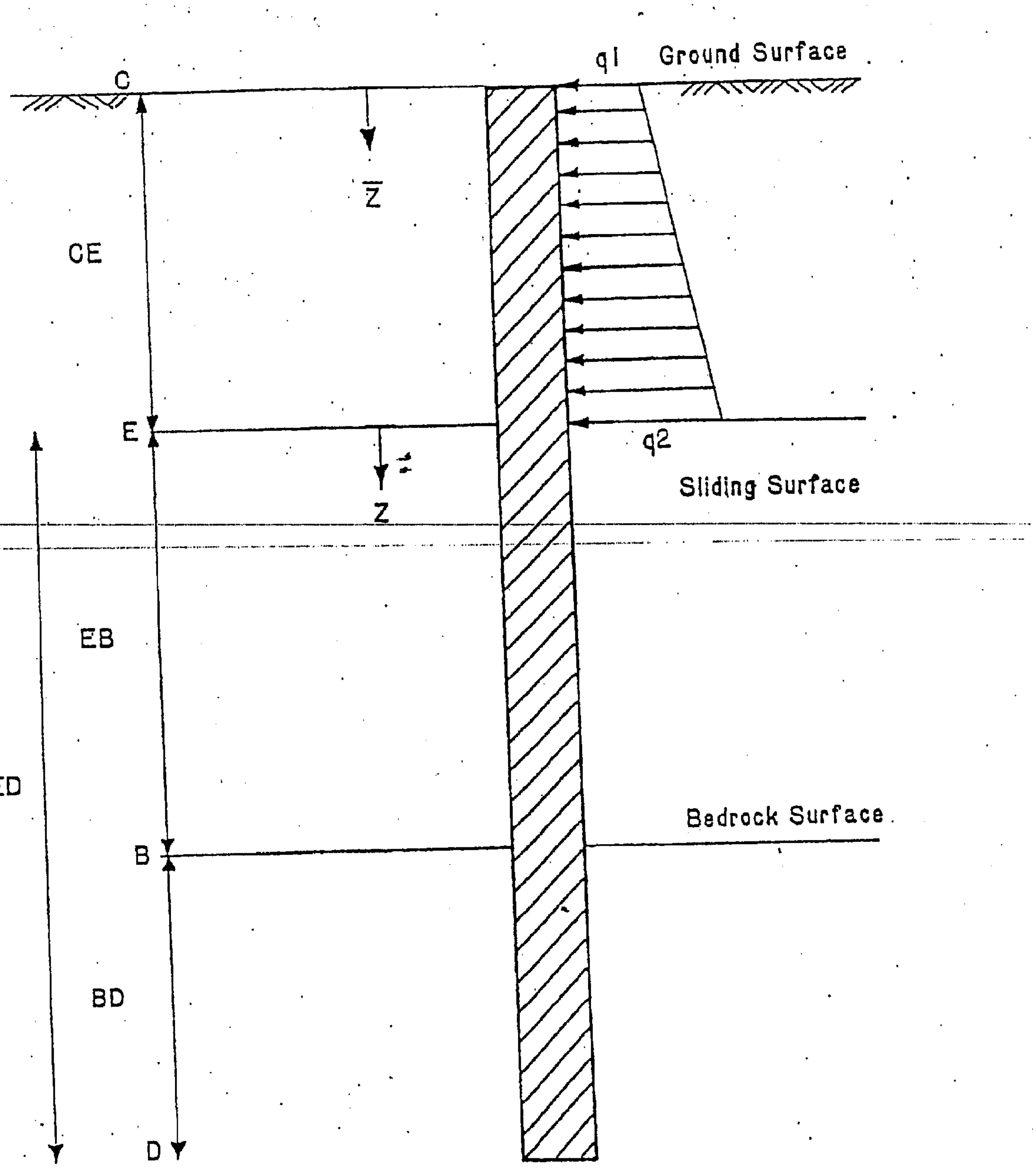

FIG. 7. Stabilizing Piles Embedded in Bedrock

1. A parameter that represents the degree of mobilization of the force F_p, must be chosen. One can assume either of the following: (1) Total mobilization of F_p; or (2) partial mobilization of F_p. In these examples, a force $F_m = F_p/F_c$ is used to represent the reaction provided by the piles. This assumption will provide a conservative assessment of the stability of the reinforced slope. To achieve a conservative design, the notion of a partial mobilization of the force may be omitted in the analysis of the piles.
2. The horizontal distance, S, between the pile row and the toe of the slope, may be dictated by site conditions or arbitrarily chosen. In this example, S is assumed to be 7.6 m. When the piles are placed at that location, the distance from the ground surface to the newly obtained critical surface, CE' is equal to 5.0 m.
3. The factor of safety of the reinforced slope can be found as a function of the pile diameter, b, the center-to-center pile row upslope, S. The effects of both the pile spa and diameter on the factor of safety of the slope ca expressed conveniently by a plot of the factor of sa versus the ratio D_1/b for a given value of S (Fig. 9
4. A desirable factor of safety for the slope is selected this example, it is assumed that the required facto safety is 1.30.
5. Based on the required FS, a ratio D_1/b can be sele from Fig. 9. In this example, the ratio should be than 2.8 to satisfy the requirement of a minimum tor of safety of 1.30 for the slope. Hence, a conserv value of 2.5 is chosen here. Large ratios of should be avoided because the assumption of a p state around the piles, as was used in the derivati (1) is not fulfilled for excessive spacing betwee piles.
6. In the initial design stat chosen. In the present e to be 0.61 m in diamet

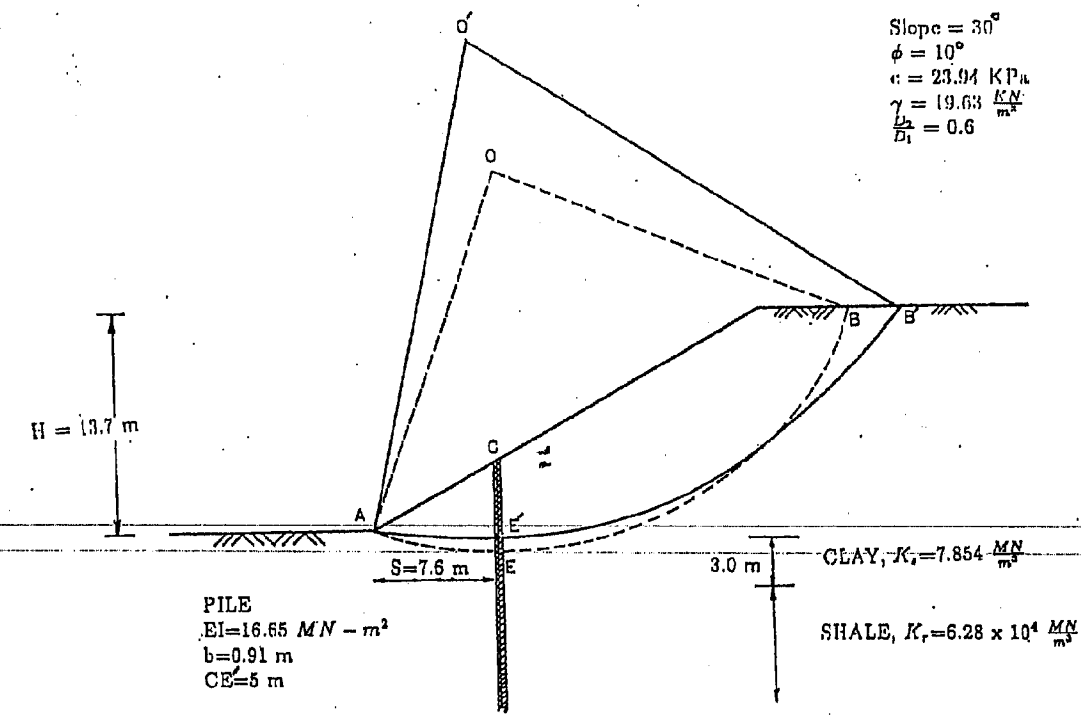

FIG. 8. Slope Configuration of Example Problem

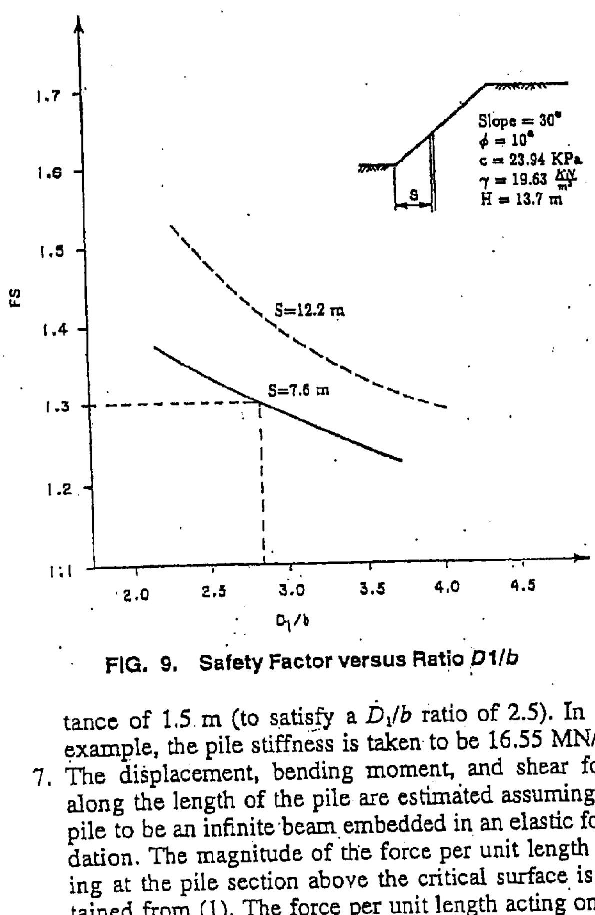

FIG. 9. Safety Factor versus Ratio $D1/b$

tance of 1.5 m (to satisfy a D_1/b ratio of 2.5). In this example, the pile stiffness is taken to be 16.55 MN/m^2.

7. The displacement, bending moment, and shear force along the length of the pile are estimated assuming the pile to be an infinite beam embedded in an elastic foundation. The magnitude of the force per unit length acting at the pile section above the critical surface is obtained from (1). The force per unit length acting on the pile section below the critical surface is a function of both the pile stiffness and the nature of the foundation. In this example, the foundation consists of a clay layer, which extends 3 m below the critical surface and is ... action of the clay is assumed to be 7.85 (MN/m^3), while the bedrock is a soft shale with a coefficient of subgr- reaction of 6.28 × 10^4 (MN/m^3).

The displacement, bending moment and shear profiles corresponding to the selected parameters are given in Figs. 10–12 for the following four possible boundary conditions (BC = 1, 2, 3, 4) at the pile top: (1) Free head; (2) unrotated head; (3) hinged head; and (4) fixed head. The hinged head condition results in the smallest bending moment in the pile, followed in order by conditions (4), (2), and (1), as seen in Fig. 11. Based on this, a restrained pile head (hinged or fixed) is recommended. In addition, experimental results (Ito and Matsui 1975) indicate that the lateral load acting on the piles due to plastically deforming ground can best be estimated by the theory of plastic deformation under the condition of a restrained pile top. Therefore, the free head condition should be avoided in order to limit the moment and shear on the pile and closely estimate the force acting on the piles. A restrained head condition can be obtained by connecting the pile heads with a beam which is fixed by tension anchors. The unrotated head condition can be obtained by simply connecting the pile heads with a beam. The constraint used for pile analysis should simulate the conditions in the field as closely as possible. In this example, the fixed head condition was assumed.

8. The structural analysis of the pile can now be performed. The maximum displacement, moment, and shear acting on it are the three parameters that should be considered to assure that the design is adequ
9. An optimum design can be obtained by minimizi ... cost of materials and construction for different configurations of the slope/pile system. The two parameter that can be varied are the pile diameter, b, and S. Fo this example, increasing the pile diameter from 0.61 m to 0.91 m increases the re piles from 1.5 m to 2.3 m proximately 305 m wide,

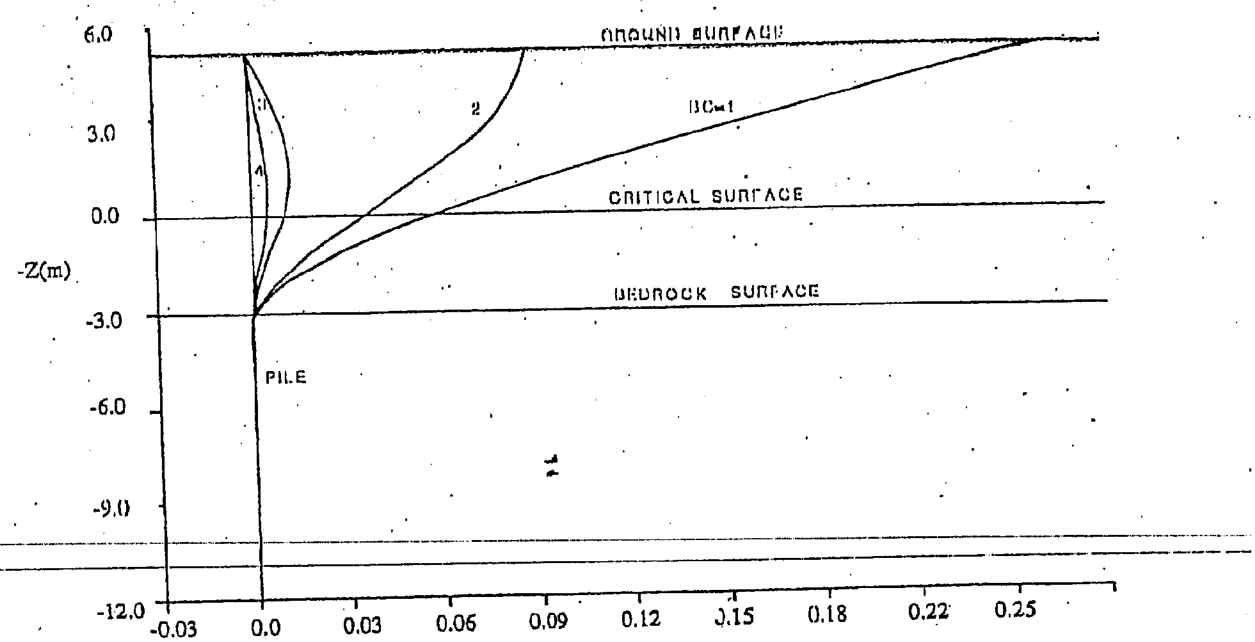

FIG. 10. Displacement along Pile—Four Boundary Conditions

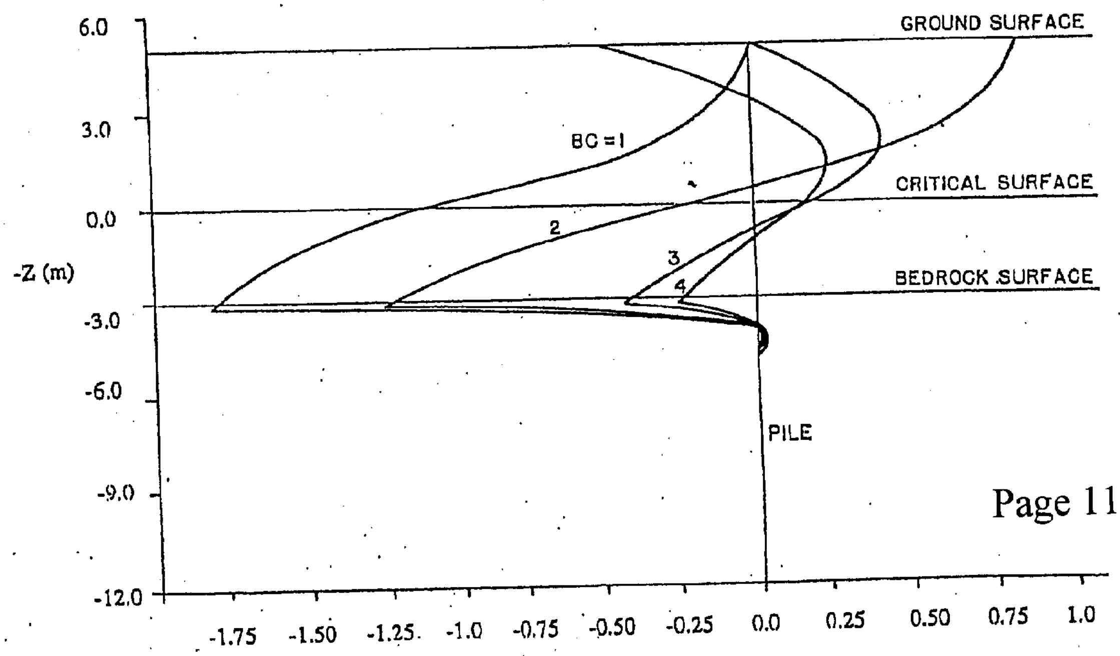

FIG. 11. Bending Moment along Pile—Four Boundary Conditions

G

ameter or 134 piles of 0.9 m in diameter will assure a factor of safety of 1.30. Increasing S has a similar effect. To illustrate this, the factor of safety is plotted against the ratio D_1/b for a distance $S = 12.2$ m (broken line in Fig. 9). In this case, to achieve a safety factor of 1.3, the ratio D_1/b must be equal to 3.5. Therefore, only 143 piles of 0.61 m in diameter or 100 piles of 0.9 m in diameter are required. However, placing the piles 4.6 m further upslope increases both the pile length required to penetrate the critical surface and the

tive could prove to be less economical than the fir one. Other design considerations would include the d gree of difficulty in the installation of a pile row at eac location, and labor costs.

10. Finally, the length of the piles can be determined. It suggested that the pile be embedded to a sufficie depth so that the bending moment and shear force a proach zero at that depth. To find the approxima depth, a pile of infinite length is analyzed and the poi at which these values approach zero is located. Embe ding the pile deeper than this point will not increa

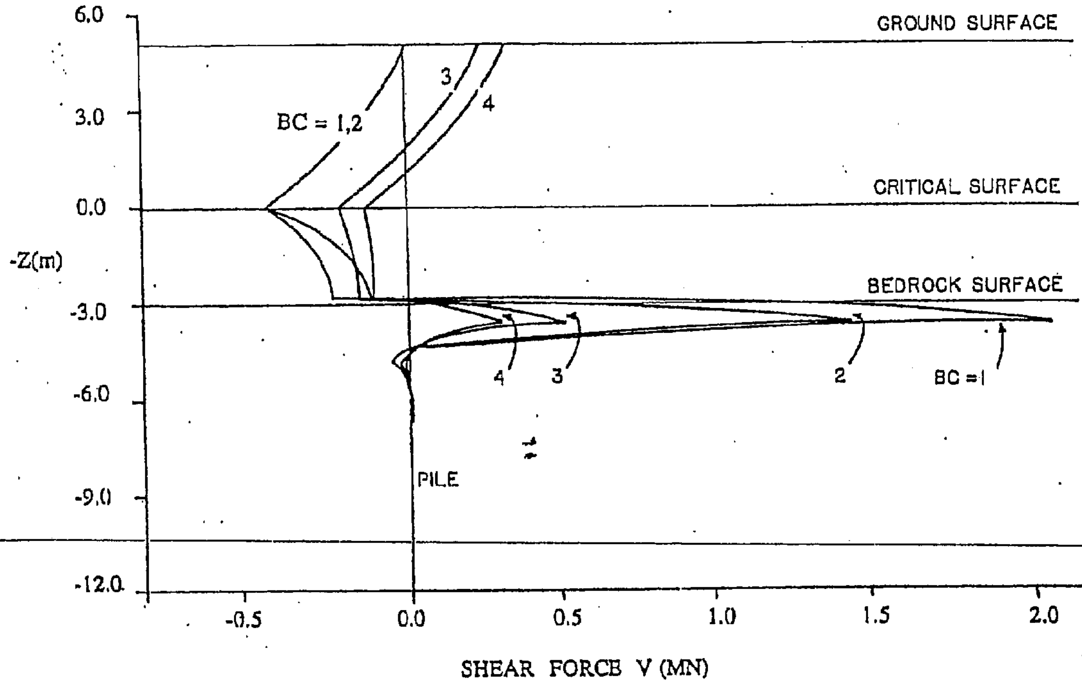

FIG. 12. Shear Force along Pile—Four Boundary Conditions

stability. The embedment length decreases considerably as the stiffness of the foundation material increases.

SUMMARY AND CONCLUSIONS

A methodology has been developed for design and analysis of slopes stabilized with a row of piles, accounting for changes in the critical surface due to the presence of the piles.

- The plastic state theory developed by Ito and Matsui (1975) was used to estimate the pressure acting on the piles regardless of the state of equilibrium of the slope. The theory was originally developed for rigid piles but was extended to flexible piles under the assumption of small deformation (Ito et al. 1981). The soil is assumed soft and able to deform plastically as it reaches a state of eminent failure through the piles. The piles are assumed to be close to each other and to act as a group.
- The friction circle method for slope stability has been modified to take into account the force exerted by the piles on the slope. It is recommended that the maximum force determined using the plastic state assumption, be divided by the factor of safety of the slope to obtain the mobilized force.
- Studies have been performed to obtain relationships between the safety factor and parameters such as pile diameter, center-to-center distance, and location of the pile row.
- The pile is analyzed in two sections to compute the displacement, bending moment, and shear force at each point along the pile. The section above the critical surface is solved using a closed-form solution since the pressure that acts on this section is known. The section below the critical surface is analyzed as a Winkler foundation using the finite difference method.
- A step-by-step procedure has been proposed for the design of both the slope and the piles. When a desired safety factor and a location of the pile row are chosen, the pile diameter, center-to-center distance, and required strength can be determined so that both the slope stability and the

The most important conclusions of this study are as follows:

- As the distance S, which indicates the pile locatio slope, increases, the factor of safety changes at a ra pending on the ratio of D_2/D_1. As this ratio decreases, the rate of change in the safety factor increases. The ratio D_2/D_1 should be such as to permit the piles to be close to each other and to act as a group.
- For a maximum factor of safety, the piles must be placed in the upper middle part of the slope. Generally, they must be located closer to the top of the steeper slopes than of the shallower ones.
- The pile top should be restrained (fixed or hinged end) to minimize the bending moments and shear forces on the piles.
- A satisfactory design of the slope/pile system can be achieved to satisfy the stability of the slope and to ensure the structural integrity of the piles.

APPENDIX I. REFERENCES

Coyle, H. M., and Bierschwale, M. W. (1983). "Design of rigid shafts in clay for lateral load." *J. Soil Mech. and Found. Div.*, ASCE, 109, 1147–1164.

D'Appolonia, E., Alperstein, R., and D'Appolonia, D. J. (1977). "Behavior of a colluvial slope." *J. Soil Mech. and Found. Div.*, ASCE 93, 447–473.

DeBeer, E. E., and Wallays, M. (1970). "Stabilization of a slope in schis by means of bored piles reinforced with steel beams." *Proc., 2nd Int Congress Rock Mech., Vol. 3*, 361–369.

Hassiotis, S., and Chameau, J. L. (1984). "Stabilization of slopes using piles." *Rep. No. FHWA/IN/JHRP-84/8*, Purdue Univ., West Lafayette Ind.

Ito, T., and Matsui, T. (1975). "Methods to estimate lateral force on stabilizing piles." *Soils and Found.*, 15, 43–59.

Ito, T., Matsui, T., and Hong, W. P. (1981). "Design method for st ing piles against landslide-one row of piles." *Soils and Found.*, 21 21–37.

Ito, T., Matsui, T., and Hong, W. P. (1982). "Extended design metho for multi-row stabilizing piles against landslide." *Soils and Found.* 22 1–13.

Nethero, M. F. (1982). *Slide contr walls to landslide control prob*

Poulos, H. G. (1973). "Analysis of piles in soils undergoing lateral movement." *J. Soil Mech. and Found. Div.*, ASCE, 99, 391–406.
Taylor, D. W. (1937). "Stability of earth slopes." *J. Boston Soc. of Civ. Engrs.*, 24(3), 337—386.
Viggiani, C. (1981). "Ultimate lateral load on piles used to stabilize landslides." *Proc., 10th Eur. Conf. on Soil Mech. and Found. Engrg., Vol. 3*, 555–560.
Winter, H., Schwarz, W., and Gudehus, G. (1983). "Stabilization of clay slopes by piles." *Proc., 8th Eur. Conf. on Soil Mech. and Found. Engrg., Vol. 2*, 545.

APPENDIX II. NOTATION

The following symbols are used in this paper:

c = cohesion intercept for soil;
D_1 = center-to-center distance between piles;
D_2 = opening between piles;
EI = pile stiffness;
H = slope height;
i = slope inclination angle;
K = modulus of subgrade reaction;
q = lateral force per unit thickness of soil;
x, y, v = angles defining friction circle;
y_1 = pile deflection above critical surface;
y_2 = pile deflection below critical surface;
z = depth along pile from critical surface;
$\bar{z}$ = depth along pile from ground surface;
γ = unit weight for soil; and
ϕ = angle of internal friction for soil.

G12

Applicant's Response to New Information provided at the August 16, 2000 Planning Commission Public Hearing (WRG 00-00002 – Riverfront Commemorative Park and Riverbank Ecological Restoration Plan)

This document includes the Riverfront Park project team's written responses to new information provided at the August 16, 2000 public hearing before the Corvallis Planning Commission. In this document, we address the six issues identified below in the Table of Contents. We have also provided four new factual exhibits (plus two attachments), identified under the New Exhibits List. As with our previous response memorandum, most of the exhibits were derived from information provided in the original application. All are based on information that has been available to the public since at least January of this year.

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New Exhibits List

A. Fire Access Documentation (Assistant Fire Chief Keith Response to Council Questions, accompanied by Council Minutes from November 23, 1999 Meeting)

B. Floodplain Impacts (CH2M Hill Memorandum)

C. Shear Piles and Impacts to Riparian Trees (CH2M Hill Memorandum, accompanied by *Riverbank Stability Analysis Peer Review for the Corvallis Riverfront Project* and *A Summary of Ecological Risks and Potential Impacts to Riparian Vegetation Imposed by Shear Piles and Micropiles*)

D. Rebuttal Comments Addressing Geotechnical Slope Stability and Stabilization of the Riverbank Using Pilings (CH2M Hill Memorandum)

A. Fire & Life Safety Access

Several persons testified in opposition to the proposed width of First Street travel lanes and sidewalks. As indicated in the application narrative, First Street travel lane widths have been reduced below residential street standards to minimize impervious surface areas and to maximize open space between the river and downtown development. Wide sidewalks (10' plus planter strips) allow for existing and future sidewalk cafes and exhibitions, as called for in adopted plans.

As indicated in **Exhibit A – Fire Access Documentation**, the Assistant Fire Chief addressed the 20' requirement in detail in testimony before the City Council.[1] She pointed out that new high-occupancy buildings (*e.g.*, taverns and restaurants) require direct frontage to a 20' or wider public roadway. Public sidewalks in high pedestrian use areas can become obstructed – by people, kiosks, street furniture, or temporary activities – and therefore are not recommended as back-up emergency access lanes. Although the 20' requirement could be met by allowing emergency vehicles to use sidewalks in cases of emergency, this approach was not recommended in the downtown area, for safety and maintenance reasons.

This is not a new issue. Those who have followed this process are aware that the Council considered First Street pavement width issues at some length at its November 23, 1999 meeting. (See attached November 23, 1999 Council Minutes, pp. 581-593.) The Council's deliberations were informed by testimony from the Assistant Fire Chief Keith:

> ***"Assistant Fire Chief Keith stated it is very difficult to provide access and deal with fire protection needs if a building accommodates a public assembly with an adjacent access way of less than 20 feet. She explained that fire engines are 8-10 feet wide. During a structure fire, one engine is staged; and other emergency vehicles (fire trucks and/or ambulances) must be able to pass the staged engine. Alternatively, if a ladder truck must be positioned for roof access, 18 feet are required for staging. For buildings of one or two stories, street width is not a major problem; however, the problem is greater for taller buildings because of the lack of appropriate width for vehicle staging."***

The Assistant Fire Chief also addressed the City Hall example cited by opponents[2] of the proposed two-way street system in her November 1999 memorandum:

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[1] Because this issue was not addressed in detail in the application narrative, and because new information was presented regarding this issue for the first time before the Planning Commission on August 19th, we have provided a copy of the November 23, 1999 Council minutes. These minutes, at pages 581-593, provide a detailed discussion of the public safety and planning reasons why the Council selected a 20' minimum street width.

[2] See photograph of City Hall, provided for the first time to the Council on August 19th. The caption reads: "Is City Hall in Compliance? If it's good enough for City Hall, why not the Riverfront."

"In certain cases, a developer/property owner can meet the intent of the code without meeting the strict interpretation of the code. A case in point: the new plaza in front of City Hall reduced the width of Madison Avenue to less than 20' – the roadway to which City Hall discharges. However, City Hall is fully sprinklered, is not a public assembly occupancy, and 5th Street and the parking lot side both give more than 20' of access width to each side of the building. The Fire Chief and Building Official determined that this met – or even exceeded – the intent of the code."

In conclusion, the design of First Street was the result of a decision-making process that balanced a variety of conflicting values. On the one hand, First Street could have been designed as a standard downtown street, with parking on both sides, for the full length of the park. This approach would have benefited most downtown businesses and provided for emergency vehicle access. However, this approach would have reduced open space between the river and downtown development. On the other hand, First Street could have been designed as a one-way, narrow street with rolled curbs and sidewalks used for emergency vehicle access – as suggested by Friends of the Riverfront and others. However, this approach would not have encouraged public assembly uses along First Street, would have reduced opportunities for sidewalk cafes and other beneficial uses within the public right-of-way, and would have been inconsistent with the recommendations of the Fire Department. We believe the proposed plan achieves an appropriate balance, by minimizing the width of travel lanes, providing for multi-purpose sidewalks necessary for a "vibrant downtown", and assuring safe emergency vehicle access.

B. Floodplain Balanced Cut and Fill

Exhibit B – Floodplain Impacts, responds to claims made for the first time a few days before the August 16th public hearing, that the applicant was "double counting" in its calculations of flood plain impacts. As explained in the CH2M Hill memorandum, the net impact of the south and north parking lots (both approved under WRG 99-3) was an increase in flood holding capacity of 1,700 cubic yards. The current proposal includes 40 cubic yards of fill. Thus, after considering the impacts of WRG 99-3 and WRG 00-0002 (this application), there is a net "cut" of 1,660 cubic yards.

C. Effectiveness of Riverbank Stabilization Methods

James Robbins submitted lengthy oral and written comments criticizing the "Riverbank Stability Analysis Peer Review".[3] CH2M Hill responds to these criticisms in **Exhibits C**

[3] Dr. Robbins provided over 20 pages of new testimony, much of it related to methods approved by a peer review team comprised of six OSU professors, two CH2M Hill engineers, and representatives from the US Army Corps of Engineers and the US Forest Service. The *Riverbank Stability Analysis Peer Review* has been available for public review since January 4, 2000. Since the Council relied on this document in making its determination to use a combination of shear and micro pilings as the least intrusive means of stabilizing the riverbank, we have provided a copy of the peer review to the Planning Commission.

– Shear Piles and Impacts to Riparian Trees and D – Rebuttal Comments Addressing Geotechnical Slope Stability and Stabilization of the Riverbank Using Pilings. In summary, the methods approved by peer review experts are consistent with sound engineering practices, and represent an effective way to stabilize the riverbank while preserving existing native vegetation along the riverbank.

Dr. Robbins also criticizes the use of rip-rap at the south end of the park, in part because it is difficult to stop blackberry growth among the rocks.[4] However, this method of bank stabilization was approved under WRG 98-2, and is not a part of this application.

Dr. Robbins' primary point appears to be that greater reliance should have been placed on non-mechanical methods (vegetation) of achieving slope stability. However, such an approach would not have allowed other improvements called for in the Riverfront Master Plan or the 1998 bond measure (*e.g.*, plazas, farmers market, viewing areas, reconstruction of the multi-use trail). More importantly, in the view of project engineers, such an approach would have increased the probability of future slope failures. Again, we suggest that the design proposed in the Riverfront Park proposal achieves the balance called for by WRG criteria—by maximizing public access and viewpoints to the river, preserving riverbank vegetation, and minimizing the risk of slope failure.

D. Significant Goal 5 Resources

Some of the testimony received by the Planning Commission on August 16th implied that the entire Riverfront Park was a significant (*i.e.*, protected Goal 5) natural resource. It is important to distinguish between the developed portion of the park above the top-of-bank and the riverbank riparian area. The developed portion of the park is not a "natural area" as defined by the Corvallis Comprehensive Plan; it is intended for active recreational use. As indicated in the application narrative (pp. 37-38), the Willamette River and its riverbank are inventoried Goal 5 fish and wildlife habitat areas with recognized scenic value. However, the developed park area is not identified as a significant Goal 5 resource in the Comprehensive Plan.[5]

Contrary to testimony submitted last Wednesday, redevelopment of the existing developed park area for recreational use – while protecting the Willamette River's vegetative fringe – is fully consistent with WRG criteria related to protection of riparian areas, fish and wildlife habitat, and scenic viewpoints and views. The existing use of the area between First Street and the top-of-bank is a developed park; this developed area is not protected by Comprehensive Plan Policies 3.1.1, 3.1.2, 3.5.2, or 3.5.4 related to "significant natural features". Rather, Policy 5.1.4 (which "encourages open

[4] The *Riverbank Ecological Restoration Plan* recognizes this difficulty and commits the City to a 10-year program to eradicate invasive plants and replace them with native plant species.

[5] Unlike several other parks in Corvallis, Riverfront Park is not identified as a "natural area" on the Parks and Open Space Inventory, which serves as a reference document to the Comprehensive Plan. This point was made in proponent testimony on August 16th.

space/recreational uses which are consistent with adopted greenway policy and development regulations along the Downtown Riverfront") applies to redevelopment of the upper portion of Riverfront Park.

E. Open Space Interpretation

Dr. Watson suggested that the applicant's efforts to interpret the term "open space" – in the context of WRG Criterion "j" – amounted to "spin-doctoring". We respectfully disagree. When interpreting the code, it is important to refer to definitions in the code and to past City interpretations. As indicated in the July 12, 2000 Staff Report (p. 19):

> ***"It should also be noted that when analyzing a typical development application to determine 'lot coverage" and 'open space', past practice has been to calculate buildings, parking lots, and vehicle circulation areas as 'impervious surface' and to calculate sidewalks, landscaping, natural areas, pedestrian plazas, and multi-use paths as 'open space'".***

This interpretation is consistent with the only code definition of "open space" that we know of:

> ***"Open Space, Group. Areas intended for common use either privately owned and maintained or dedicated to the City, designed for outdoor living and recreation or the retention of an area in its natural state, and normally including <u>swimming pools, recreation courts, patios, open landscaped areas, and greenbelts with pedestrian, equestrian, and bicycle trails</u>. Does not include off-street parking or loading areas or driveways."*** (Emphasis provided.)

A reasonable interpretation of past City practice and this definition would be to include <u>all</u> park improvements within the definition of "open space".[6] Opponents to the proposed Riverfront Park have equated "vegetated areas" with "open space", arguing that WRG Criteria "j" (Section 3.30.40.j) was violated because the proposal does not maximize vegetation between the river and development.

However, a closer reading of Criteria "j" makes it clear that "landscaped area, open space <u>or</u> vegetation" should separate the river from development. If vegetation were intended to be the same as "open space" or "landscaping", then the text of Criterion "j" would not have made this distinction. The term "open space" clearly incorporates public improvements that are typical of park development.

In conclusion (and as stated in the application narrative), this proposal represents what Oregon's Willamette River Greenway program was intended to achieve. Downtown buildings are confined to the area west of First Street. Existing gravel parking areas will

[6] In our August 7, 2000 Response Memorandum, we excluded sidewalks and plazas when measuring "open space" and included only the multi-use trail and seatwalls. In contrast, Ms. Lidwell's assessment of "open space" included only vegetated areas in the developed portion of Riverfront Park vegetation, and excluded the riverbank entirely. Her interpretation is inconsistent with past City interpretations and the clear language of the code.

be moved away from the River – to the south and north ends of First Street. Open space – defined appropriately as developed park area – has been maximized between downtown development and the river. The "vegetative fringe" (the riverbank and associated fish and wildlife habitat) will be protected and enhanced. The Willamette River Greenway program never intended to prohibit cities from redeveloping existing riverfront parks for recreational uses, so long as the vegetative fringe is protected.

F. Impact of Pilings on Riverbank Tree Roots

Joanne Taylor presented evidence to the effect that shear and micro-piling construction could result in root rot and loss of trees along the Riverbank. As documented in **Exhibit C – Shear Piles and Impacts to Riparian Trees**, this possibility exists and was examined by the Oregon State University Scientists and presented to the City Council at the March 6, 1999 meeting. The OSU team concluded that three trees would likely die as a result of piling construction.

To address potential tree mortality resulting from such construction, the City is committed to "revegetation of areas affected by riverbank stabilization." As stated in Appendix 5 to the original application narrative (Report to City Council, April 3, 2000, *Ecological Restoration of the Corvallis Riverfront—Summary of Action Items*, pp. 7-8):

> ***"The restoration of the Corvallis Riverbank will require a multi-year commitment to controlling invasive species, and developing and maintaining the desired plant species composition and distribution. * * * Native vegetation will be planted in areas where construction activities related to bank stabilization, park development, and slump repair have damaged existing vegetation or created areas of bare soil. * * * Installation of riprap has damaged trees and covered potential regeneration sites. In addition, installation of shear pile walls for bank stabilization may kill or damage a small number of trees. We will incorporate revegetation techniques described above to revegetate damaged areas and reduce erosion."***

Once again, this is not a new issue. It is an issue that was examined in detail by the project team, the Riverfront Design Committee and the City Council. Staff recommended condition #1 already addresses the limited potential for riverbank tree mortality, by requiring compliance with the *Riverbank Ecological Restoration Plan.*

EXHIBIT A

Fire Access Documentation

(Assistant Fire Chief)

CITY OF CORVALLIS
COUNCIL ACTION MINUTES

November 23, 1999

SUMMARY OF DISCUSSION

Agenda Item	Information Only	Held for Further Review	Decisions/Recommendations
Unfinished Business 1. Discussion of and Deliberations on the Riverfront Park Plan Design • Response to Councilors' questions • General riverfront parking issues • Discussion of alternate plans for area of B Avenue and Western Boulevard • Councilors' comments concerning proposed park plan • Angled parking on East-West streets • Sidewalk café layouts • Sidewalk between Jefferson Avenue and Western Boulevard Page 582-608		Next meeting: November 29, 1999	

Glossary of Terms:

ASC Administrative Services Committee
CM City Manager
HSC Human Services Committee
U Unanimous
USC Urban Services Committee

CITY OF CORVALLIS
COUNCIL ACTION MINUTES

November 23, 1999

The regular meeting of the City Council of the City of Corvallis, Oregon, was called to order at 7:00 pm on November 23, 1999, in the Downtown Fire Station, 400 NW Harrison, Corvallis, Oregon, with Mayor Berg presiding.

Explanation of shirt:

PLEDGE OF ALLEGIANCE

Mayor Berg introduced Alan Lankin, who is an associate attorney in the City Attorney's Office and would be offering assistance to the Council during the meeting.

Mayor Berg stated she felt it appropriate to explain her unusual attire for the meeting. She explained that Mayor Jim Torey of Eugene presented her with a challenge concerning the outcome of the Oregon State University (OSU) versus University of Oregon (UofO) "Civil War" football game the previous Saturday. She explained that if the Beavers won, he would borrow a sweatshirt from Dee Andros and wear it while presiding at a televised Eugene City Council meeting. Unfortunately,the UofO Ducks won the game, and Mayor Berg was required to wear a UofO Duck sweatshirt while presiding at a televised Corvallis City Council meeting. She reported telling Mayor Torey that she expects all Eugene citizens to cheer for the Beavers during a bowl game in Hawaii, and all Corvallis citizens will cheer for the Ducks during a bowl game in El Paso. She reported warning Mayor Torey to "wait until next year" and cheered "Go Beavs"; the Council and staff responded with enthusiastic cheers and pom-pom waving.

I. ROLL CALL

PRESENT: Mayor Berg, Councilors Peters, Schmidt, Wogaman, Beilstein, Griffiths, Tomlinson, Barlow-Pieterick, Grosch, Howell

Mayor Berg directed Councilors' attention to items at their places, including a note from the City Recorder announcing the availability of video taped excerpts of September and October 1998 Council deliberations concerning Hilton Garden Inn (she noted that Councilors who were not in office during September and October 1998 must review the tapes prior to the December 6th Council meeting); a memorandum to Mayor Berg and the Council from City Manager Nelson concerning the format of the November 23rd Council meeting; a table of the Corvallis Downtown Parking Commission's (DPC) revised short-term action plan schedule as of November 1999; the Willamette Riverfront Park Alternative Design from the "Where's Our Park" Committee; photocopies of Tom Jensen's riverfront park proposal; e-mail messages to Mayor Berg from Heather Crawford, Heather Morrison, Carol Anspacher, Michael Mullejans, and John Swanson; an e-mail message to Mayor Berg and the Council from Richard Bryant; a letter to Mayor Berg from Adam Quinn of Boy Scout Troop 186 inquiring, in part, about the riverfront projects in conjunction with work on his Citizenship in the Community merit badge; a letter to Mayor Berg from Mater Investment Company; a letter to the Council from Michael Pope; 15 questions submitted by Councilor Griffiths with notes and responses from Mr. Nelson and staff; and a letter to the Council from Brian Bucola.

II. UNFINISHED BUSINESS

A. Discussion of and Deliberations on the Riverfront Park Plan Design

Mayor Berg reviewed the format for the meeting, stating Councilor Tomlinson would like to present a motion concerning the Design Review Committee's (DRC) compliance with Council direction; Mr. Nelson and staff will answer questions submitted by Councilors; and Councilors may ask follow-up questions but were requested to ask one question at a time to avoid monopolizing the discussion. She stated that questions that cannot be answered during the meeting must be supported by a majority of the Council before staff will invest time in researching answers. All Councilors will be asked for their comments, but she asked them to confine their comments to five minutes. The Council will then address issues referred to the Council by the DRC concerning possible alternatives, specifically B Avenue, 45-degree versus 60-degree angled parking, etc. She stated the Council will then deliberate toward a motion of direction to staff, contingent upon consultation of bond counsel and integration with riverbank stabilization.

Councilor Tomlinson presented the following motion for Council consideration:

"Whereas, the City Council adopted the Riverfront Commemorative Park Master Plan, as amended, on February 26, 1997; and

"Whereas, the Design Review Committee was established with the charge 'to work on design review issues as outlined by Council' in the February 26, 1997, meeting; and,

"Whereas, the Design Review Committee presented the Riverfront Commemorative Park Master Plan to City Council and the citizens of Corvallis on November 18, 1999; and

"Whereas, the City Council will now begin our deliberations regarding the Riverfront Commemorative Park Master Plan;

"Now, therefore, I move:

"a) The City Council acknowledges that the recently presented Riverfront Commemorative Park Master Plan complies with the February 26, 1997, adopted and amended Park Master Plan; and

"b) The City Council recognizes our desire to deliberate the design alternatives brought forward by the Design Review Committee; and

"c) The City Council considers further refinements to the plan might be required based on public testimony, riverbank stabilization strategy, or other new information; and

"d) The City Council extends, to the Design Review Committee, the Riverfront Commission, the Riverfront Enhancement Task Force, and all citizens who testified our thanks for their work and interest in the Riverfront Commemorative Park."

The motion was seconded.

Councilor Beilstein stated he supports the motion, noting it clearly states the Council's position. He noted that the Council is grateful for the DRC's work; but the decision to approve the plan is, ultimately, dependent upon the decision and judgment of the present Council and not the decisions of the Council in office during February 1997.

Councilor Griffiths stated she supports the motion and opined the Council cannot adequately thank the people who were involved in numerous meetings, participated in formal City-sponsored meetings, and participated in other ways, even though not formally appointed, but followed the public process and gave testimony. She noted she was present at the February 26, 1997, meeting and recently reviewed the items assigned to the DRC; she noted the DRC received and interpreted the Council's direction and did a very good job of balancing competing interests.

The motion passed unanimously.

Councilor Wogaman, as chair of the DRC, expressed his appreciation for the motion. He stated he did not regard passage of Councilor Tomlinson's motion to serve as a commitment on any Councilor's part to vote in any specific manner on any implementation proposal or idea presented.

Mr. Nelson stated that staff has researched answers to Councilors' questions as presented during the November 18th meeting. He noted the questions covered all aspects of the riverfront park plan. (The questions and responses are attached to these minutes.) He briefly reviewed some of the questions, beginning with Councilor Griffiths' questions.

Can we see an overlay of the hard surfaces, structures, plazas, roads, sidewalks, etc. relative to the factor of safety (FS)line 1.3? When will the data regarding the FS line be verified? He responded the data should be available for presentation to the Council during the December 6th Council meeting.

What does the Fire Code permit for road width? 20 feet? Can this be accommodated by a street less than 20 feet with a drive-up sidewalk? Other alternatives? How about temporary structures in the 20-foot width? He responded that Assistant Fire Chief Fire Marshall Claire Keith prepared a written answer to this question and its variations, as presented by Councilors Tomlinson, Peters, and Howell. He noted the Fire Code specifies that all new buildings be provided with a minimum 20-foot wide access road to within 150 feet of any portion of the exterior of that building. Buildings containing public-assembly-type occupancies (e.g., restaurants, taverns, meeting rooms, etc. for 50 or more people) must front directly on or discharge to a public roadway not less than 20 feet wide. He reviewed the reasons for the 20-foot requirement, citing the widths of the various fire apparatus that might be dispatched to the building. He noted that some exceptions have been made to this requirement, when another "mountable" surface is constructed to support fire apparatus weight, but cautioned that street maintenance and cleaning is compounded by rolled curbs and structures along the curbing. He noted that the City's Building Code is more restrictive, and proposals of less than 20 feet are reviewed by the Fire Code and Building Code staff.

He noted some exceptions have been made when the intent of the code is met, such as City Hall, which has extensive fire sprinklers and more than 20 feet of clearance on the parking lot side of the building. Temporary structures in the 20-foot width are reviewed individually.

What are the current sidewalk standards for Downtown development along the riverfront? What do standards say about sidewalk location relative to property line? How flexible are these standards? He noted Councilor Tomlinson asked a similar question. He stated the City does not have an established maximum sidewalk width, but the impact on future street lane needs, landscaping requirements, and impervious surfaces are considered. He stated that sidewalk cafés are limited to the Central Business District, Central Business Fringe, Shopping Area, and Shopping Area University. He noted that sidewalk cafés must maintain a six-foot clearance from the edge of the café to the edge of the curb with three feet being clear of all impediments for Americans with Disabilities Act (ADA) requirements. He stated that sidewalk cafés must be operated within ten feet of the public sidewalk and noted the Municipal Code governs operation standards concerning sidewalk cafés; however, the Municipal Code can be amended by the City Council. He noted that Police Chief Roskowski and Lieutenant Sassman prepared a response concerning sidewalk width requirements for sidewalk cafés, related Municipal Code provisions, and Oregon Liquor Control Commission license requirements concerning patrons of sidewalk cafés serving alcoholic beverages.

Downtown Corvallis Association (DCA) concern with restroom replacement? He stated the DCA would like to locate the restroom closer to the parking lot for greater visibility and less likelihood that it would become a hangout. He stated Parks and Recreation Director Moye talked with DCA Executive Director Joan Wessell; but no specific site was recommended.

Mater easement/deed restriction? He stated the Maters participated in improvements to Western Boulevard and the alley way and were required to meet greenway permits as part of a building renovation they initiated during the early-1980s. He noted the City would be required to meet some of the same requirements with development of the riverfront area.

Parking Commission agenda for the future? He referred Councilors to the handout distributed prior to the meeting. He noted the action plan schedule contains Council check-in points.

What will be the reaction from the Saturday Farmers' Market (SFM) if First Street angled parking changes from 60 degrees to 45 degrees and the street width changes from 60 feet to 52 feet? He stated that Rebecca Landis testified during the November 18th Council meeting that the SFM needs 60 feet in street width to accommodate vendor booths, based upon a 20-foot-wide fire access lane. He noted the 60-foot width could be reduced and still accommodate the SFM. He stressed that staff is presenting information to the Council but is not negotiating with any entity or group concerning park designs.

He stated that the Councilors' remaining questions will be addressed by the consultants.

Gordon Nicholson referenced the Councilors' questions, beginning with those submitted by Councilor Griffiths.

What trees will need to be removed from the top of the bank (between bike path and river) to build overlooks, plazas, and bike path? Specific number of trees in each location by specimen and size of trees. How many trees will be retained? He stated that the consultants do not intend to remove any of the naturally occurring trees east of the bikepath and extending over the edge of the riverbank. He stated that in the pinch-point area there may be a need to impact some of the trees, depending upon the restoration procedure utilized, and that a value will be placed on the trees with the trees assigned the lowest value (as determined by the OSU scientific team) being removed. In other areas west of the bike path the consultants do not envision impacting any trees. He noted that in the plaza areas, some established trees will be removed and replaced.

What trees will need to be removed from the park itself (from west edge of bike path to buildings) to build park features (overlooks, plazas, bike path, roads, and sidewalks)? Specific number of trees in each location by specimen and size of trees. How many trees will be retained? He stated that, essentially, all the trees between the bike path and the buildings will be removed and replaced with new, native species to the fullest extent possible. Mike Zilis noted that more trees will be planted than removed west of the bike path.

Are any non-native trees planned for removal just because they are non-native? Size and location and condition if slated for removal. Mr. Nicholson responded, "no."

Location of top of bank – Is it where bank begins to slope downward or just above that? How was this determined? Has this been done differently in different locations? He stated the consultants reviewed topographic surveys and field observations and selected points with noticeable breaks from flat surfaces to the beginning of a drop over the bank. Where this point was not discernable, professional judgment was used to link together the two points adjoining the area and extrapolate the break point. He noted that the break point varies between the northern and southern ends of the park area, with the northern end having a more gradual slope.

Will it be necessary to place any plazas and/or overlooks or parts of them on augured pilings? Which ones? How will they be constructed? What will it add to the cost versus placing the structures back from the bank behind the FS line 1.3 or farther – i.e., ten feet? He stated that the current plan involves placing the three plazas on augured pilings, and the cost sensitivity data will be reported to the Council during the January 6th meeting. He stated that the four overlooks (Western Boulevard, Washington Avenue, Adams Avenue, and Jefferson Avenue) will not be placed on augured pilings, nor will other special construction methods be used, because the pinch-point area is being stabilized, and the FS line will be moved to the top of the riverbank.

He referenced Councilor Griffiths' first question concerning construction of overlooks and plazas and the impacts on existing trees. He noted the plaza shapes were re-designed, saving 26 trees.

Where does the bike path come closer than ten feet from the "top of the bank"? He stated that in the area between Adams Avenue and Jefferson Avenue, the concept plan encroaches slightly into the ten-foot buffer. He stated this is the only area of encroachment, and the consultants are minimizing the encroachment. He stated that the bike path travels under the VanBuren Avenue bridge abutment along the edge of the riverbank; however, no other bike path location is available in the area. He stated that the bike path is ten feet from the riverbank in the area of Western Boulevard. He stated the overlook can be constructed without filling the Combined Sewer Overflow (CSO) outfall pipe area.

What is the square footage of overlooks – Western Boulevard, Washington Avenue, Adams Avenue, Jefferson Avenue? How was the decision made to have them at every block? He stated the overlooks total 9,800 square feet, a reduction of 1,700 square feet (15%) from the 10% concept plan. He stated the original concept from the Riverfront Enhancement Task Force involved inclusion of a visual connector at the end of each East-West street as an attraction to visitors. He noted the plan was approved by the Council during February 1997.

What is the square footage of each plaza? He stated the three plazas total 22,900 square feet, a reduction of 3,400 square feet (13%) from the concept plan. He noted that the changes to the overlooks and plazas total a 13.5% reduction from the concept plan.

What features are planned for these four overlooks? What do they look like compared to the 30% and the 60% designs? Mike Zilis stated the overlooks were modified, but each overlook allows pedestrian access via a raised crosswalk and standing area for river viewing. The Western Boulevard overlook contains a picnic table; the Washington Avenue overlook contains benches and corner seating; the Adams Avenue overlook contains benches and seating within the overlook; the Jefferson Avenue overlook contains seating along the edges and two raised seating edges at the north end. He stated the design follows the same considerations as contained in the original plan, but the details were refined to fit within the area available and comply with the suggestions of the DRC.

How much and where will cut and fill be required? Nicholson stated that cutting is being performed between B Avenue and Western Boulevard. He explained the work is a combination of cut and fill with an overall reduction of 600 cubic yards of earth. From Western Boulevard through the remainder of the park area, the consultant team is matching existing grades.

Parking under the Highway 34 bypass? What are the pros and cons of this idea? Is all of this area where street is proposed, Western Boulevard to B Avenue, in the flood plain – 10-year or 100-year? Mr. Zilis stated the consultant team considers parking under the Highway 34 bypass to be negative from the perspectives of visual aesthetics and traffic connectivity. A parking lot would interrupt the visual connection between the riverfront park and Shawala Park. He stated that the parking lot, if graded properly, can accommodate flood waters the same as the grass area. He stated he does not recommend grasscrete in a municipal parking lot because of daily wear and tear and the inability of the City to regenerate grass over time. He explained that grasscrete cannot be repaired quickly. He stated that the costs for initial installation and overall maintenance of grasscrete parking lots are higher than for asphalt parking lots. Mr. Nicholson stated that access to a parking lot under the Highway 34 bypass was proposed through the metered parking lot; he opined this would create an unattractive, un-natural traffic flow pattern for ingress and egress.

How does the Marys River flow come into this area under the Highway 34 bypass and how does it interact with a potential parking lot or parking along the street in the 6-7 alternatives proposed? He stated that in a 100-year flood pattern, the Mary's River overflows its banks in the area of Shawala Park and flows into the proposed parking area in an "overland flow" pattern. He stated that construction of a parking lot would not hinder the flood pattern, explaining that flood water would continue to cut across the area. The area is not in the ten-year flood plain but is in the 100-year flood plain.

B Avenue options between Second Street and Third Street on south side; already calculated in figures? How many vehicles can be accommodated at 60 degrees and at 45 degrees if south side is cut out for parking? Dan Peterson stated the 30% design drawings included 32 spaces programmed for the area at 60-degree angled parking and widening of B Avenue. The area can accommodate 35 spaces of 60-degree angled parking. He stated the area would accommodate 27 spaces of 45-degree angled parking, for a reduction of eight spaces. Mr. Nicholson stated that if 60-degree angled parking is retained, the travel lanes would narrow to 11 feet.

Can valley gutter be placed at 12 feet, rather than 11 feet, to give a narrower feel? He stated the concept is included in the current design. He explained that, in order to get the 12-foot travel lane, 11 feet are asphalt, and one foot comprises part of the two-foot-wide valley gutter. He stated this design was developed to give a sense of narrowing in the area. He speculated that a greater impact in the sense of narrowness or slow-down in the area would be the parked cars and angled parking, which, he opined, would have a greater influence on drivers.

When we have parking on one side of First Street, we have an 11-foot lane on one side and a 12-foot lane on the other; why? He explained this relates to the incorporation of the valley gutter into the design.

Does the overlook at end of Western Boulevard assume filling in tooth around outfall? He stated the overlook is not dependent upon filling the tooth and that the overlook and the fill can be done independently without impact. He stated that the consultant team has always intended to fill the cavity around the CSO outfall.

Covered bike parking and lighting adequately coordinated or policy direction sufficient? Bicycle and Pedestrian Advisory Commission (BPAC) and other designs being pursued (Madison?)? Mr. Zilis explained that a bike shelter is proposed along First Street, in keeping with the street improvements. He reported that, during the last DRC meeting, the consultant team was asked to coordinate its work with the BPAC; he noted the two groups had not met yet. Mr. Nicholson stated some concerns were expressed by bicyclists concerning lighting around the bike shelter. He reported that the reflectors and lights around the bike shelter have been altered and will match those around the Downtown Fire Station. He stated the lighting levels are compatible with the lighting of the multi-modal path and First Street.

Explore placing benches on west side of First Street in planting areas? Mr. Zilis stated that the areas available for benches would be near the pedestrian crossings. He stated the consultant team could explore bench placement in some locations with adequate width. He recommended ensuring that sight lines remain open and that circulation around the benches is efficient. He speculated that some areas on the west side of the street can accommodate benches but added that the plan for the east side of the street contains many benches. He noted that the plan inadvertently omits plantings on the west side of the Jackson Avenue plaza.

Mr. Nelson inquired if the consultants recall any DRC discussions concerning exploring options for reclaiming parking if parking were removed from B Avenue or to the north. Mr. Nicholson responded he did not recall any recent DRC discussions of this nature. He stated that during the previous 18 months, the DRC struggled to find parking adjacent to the area to maintain parking neutrality. He explained that options included extending off-street improvements as far as Fourth Street. He noted that placing parking at the south end of the park area presents another concern; namely, placing employee parking farther from the Central Business District.

Councilor Wogaman reviewed that the last Council meeting included discussion of issues for further exploration. He noted that, among the concerns, was how much parking would be lost if parking was re-located to the south and north ends of the park area, whether the Council is willing to accept the loss, and where the lost parking could be re-claimed if the loss is unacceptable. He reiterated that the DRC intended the plan to remain parking neutral as much as possible and that parking be removed from the area between VanBuren Avenue and Washington Avenue and re-located to the ends of the park area.

Mayor Berg inquired if the proposed parking under the Highway 34 bypass would interfere with the skate park or the basketball court. Mr. Nicholson responded that he did not anticipate any interference.

Councilor Peters inquired the length of the blocks and whether the blocks are measured from street centerline to street centerline or from curb to curb. Mr. Nicholson responded that, from street centerline to street centerline, the blocks are 350 feet in length.

Councilor Peters inquired if the Fire Code would permit public roadways narrower than 20 feet if a building that fronts or discharges to such a street is on a corner and has access to a side street that is wider than 20 feet. Development Services Manager March responded that buildings on corner lots that can discharge to adjacent streets would meet Fire Code requirements.

Councilor Griffiths requested clarification of the permitted exceptions to the Fire Code's 20-foot street width requirement. Mr. March responded that a sprinkler system is not necessarily a trade-off for the 20-foot street width requirement. He noted that City Hall was allowed the trade-off for reasons previously stated. He explained that requests are considered individually and that blanket approvals cannot be given without looking at all factors of a specific situation. He stated that if a building is not required to be equipped with sprinklers, installation of a sprinkler system might warrant approval of a Fire Code exception.

Councilor Griffiths referenced current and future uses of buildings along First Street. If an existing building meets the Fire Code requirements by having a different access or a sprinkler system or does not accommodate assemblies of 50 or more people, the building would not be required to have access to a 20-foot-wide street. If a mid-block building later changed its use, would other modifications be required. Mr. March confirmed and clarified that if the street was narrower than 20 feet and a new use was established which involved assembly of 50 or more people, the City must review how the building occupant could meet the Fire Code. He confirmed that a sprinkler system would be seriously considered by the City during such a review. Councilor Griffiths inquired about how alleys are considered in relation to the Fire Code. Mr. March responded that alleys are not typically used as the main egress, and fire access would typically be via an adjacent street. An alley of sufficient width could be considered but must be clear of overhead obstructions.

Assistant Fire Chief Keith stated it is very difficult to provide access and deal with fire protection needs if a building accommodates a public assembly with an adjacent access way of less than 20 feet. She explained that fire engines are eight to ten feet wide. During a structure fire, one engine is staged; and other emergency vehicles (fire trucks and/or ambulances) must be able to pass the staged engine. Alternatively, if a ladder truck must be positioned for roof access; 18 feet of width are required for staging. For buildings of one or two stories, street width is not a major problem; however, the problem is greater for taller buildings because of the lack of appropriate street width for vehicle staging.

Councilor Howell asked if activities such as SFM can maneuver within a 14-foot-wide street, referencing a proposal to reduce the street width from 60 feet to 52 feet, leaving a 14-foot clearance. Chief Keith responded affirmatively, stating that tents larger than 10 feet by 10 feet require a setback from the sidewalk. She stated that this situation has never occurred with the SFM and that 14 feet between the vendor rows is fine with the Fire Department.

Councilor Peters referenced the Fire Department's prepared response to Councilor Griffiths' inquiry about street width, specifically that the City has "... accepted roadways with less than 20 feet in width, as long as additional width is provided by another 'mountable' surface constructed to support fire apparatus weight ..." He stated the response infers that a narrower street is acceptable, as long as it is adjacent to an impervious, mountable surface providing a total of 20 feet of width. Chief Keith confirmed, stating such a setting provides the Fire Department with future issues. She cited locations on the OSU campus where parking is allowed along streets, resulting in a reduced street width. In these instances, one wheel of a fire truck can be mounted on the sidewalk to accommodate the width needed. She noted that kiosks have been placed in the sidewalk, impeding this staging maneuver. She stressed the importance of ensuring the Fire Department has clear access for the future.

Councilor Howell referenced the valley gutter and the proposal to narrow the streets and travel lanes. He inquired if it is critical for water flow to have the valley gutter at the 11-foot mark or if it could be moved to the 10-foot mark. He inquired if it is possible to incorporate the valley gutter into the travel lanes or if it must be separated. Mr. Nicholson stated that shifting the valley gutter toward the centerline is possible, noting that doing so would add one foot to the parking stall to maintain the overall street width. He opined this would create a very atypical contour to the street profile. He explained that water typically drains toward the edge of the roadway, where the surface curves upward; but under this proposal, the outside foot of the travel lane would slope upward, effectively narrowing the travel lane. Public Works Director Mann concurred, stating that engineers will not typically put a wheel path into the valley gutter but, rather, try to keep drivers closer to the centerline and within the proper width of each lane. He opined that if the gutter is shifted, drivers will not travel in it and will drive closer to the centerline. He noted that drivers traveling with one wheel path in the gutter can experience problems with drainage and slick surfaces because of the gutter slope, particularly during freezing temperatures. He recommended using valley gutters only in the center of the driving path.

Councilor Howell referenced 20-foot streets having gutters within 10-foot travel lanes and 11-foot streets having one-foot gutters incorporated into the travel lanes. He inquired if the travel lanes and the gutters can be merged, as has been done in other streets. Mr. Nicholson responded he has seen such mergers; he noted the street had no parking, and the gutter was extended to two feet. Mr. Mann cautioned that this scenario removes any factor of safety for drivers, in that there is little leeway for mistakes where traffic is moved closer to curbs and curbside sidewalks. He noted that designers usually provide three feet from the edge of a travel lane to a curb to allow maneuvering or room for driving errors, especially for streets with speeds of 30 to 45 mph. He opined that by reducing the width of the travel lanes, people will be driving very close to sidewalks, creating a reduced level of safety for pedestrians.

Councilor Howell noted that the City's Transportation Plan standard sets travel lane widths at 11 feet for collector streets and 12 feet for arterial streets. He inquired why 11 feet would not be an adequate width for the travel lanes on First Street. Mr. Mann responded that the width could be either 11 or 12 feet, but he recommended leaving a little factor of safety for people, particularly in a setting where many people are expected to be on the sidewalks. Councilor Howell noted that in some blocks the travel lanes will be ten feet and in others will be 12 feet with parking on the opposite side of the street.

Councilor Peters inquired when the consultants can get answers to the Council. Mr. Nicholson responded that, per Mayor Berg's instructions, a consensus of the Council is needed before the consultants pursue researching answers. Mayor Berg confirmed, asking Councilor Peters to make his question specific and obtain consensus of the Council. Councilor Peters stated he would rather hear comments from the Council before submitting research questions to the consultants.

Councilor Griffiths inquired if any structures exist to the east of where the FS line is believed to be located. Mr. Nicholson responded that only the plazas and overlooks are east of the FS line and noted that these structures are being reviewed. Mayor Berg noted that decisions concerning the plazas and overlooks will be made in conjunction with the riverbank stabilization.

Councilor Howell referenced the section of the bike path between the Highway 34 bypass and Western Boulevard and noted that alternative plans had the path passing through some trees. He asked if alternate routes would avoid placing the path in the trees. Mr. Nicholson responded that the alternative plans have opportunities for refinement without impacting trees. He speculated that as the alternative plans were developed, focus was placed on the street; and he stated that the path will be made compatible with the alternative plan selected by Council.

Councilor Griffiths referenced alternative plan 3 for B Avenue and Western Boulevard and inquired if the layout with parking toward the end of the park with the proposed skate park can be accommodated with access from B Avenue or a combination of B Avenue and the current parking lot. Mr. Nicholson responded affirmatively and stated the parking lot could be connected but cautioned that previous work would need to be removed, and traffic would cross the sidewalk into the parking lot. He speculated the proposal would cause traffic circulation confusion.

Councilor Schmidt referenced Washington Avenue and inquired the Fire Department's position concerning cul-de-sacs, noting that some proposals involved not continuing B Avenue to First Street. Chief Keith responded that cul-de-sacs longer than 150 feet require a bulb or hammer-head turnaround of 72 feet in diameter.

Councilor Griffiths referenced the typical sidewalk dining layout for a bulbed intersection. She requested confirmation of the measurements presented of ten feet for sidewalk, five feet for parking strip, six feet for setback, and three feet at the edge of the sidewalk. She noted that the different surfaces proposed for the different widths may pose difficulties for handicapped persons. Mr. Zilis responded that using eight feet for dining would place part of the dining area on paver blocks. He stated the pedestrian flow could be moved completely to the sidewalk by reducing the dining space.

Mayor Berg requested the Councilors' comments concerning the general decision before the Council.

Councilor Peters opined the DRC did a good job developing the plan. He stated he has some concerns but obtained some answers, especially regarding SFM's space requirements. He referenced his earlier questions about parking, expressed interest in exploring options that will impact parking, and stated he would like to explore ways to recapture the lost parking. He stated he had requested of the City Manager a walking tour of the riverfront led by either staff or the consultants. He opined that such a tour would be very useful, noting he is having trouble making all the park elements "fit" into the area cited as available. He speculated that some of the Council's questions can be more simply answered through a walking tour, such as which trees must be removed and areas where the riverbank edge calculations were extrapolated from surrounding areas. He stated he would like to hear other Councilors' comments. He opined that so many issues and questions were raised and options presented that the Council probably cannot reach a decision tonight. He reiterated his belief that a walking tour will facilitate the decision-making process. He stated that much of the plan looks good, but the Council needs to work on some of the refinements.

Councilor Tomlinson expressed his appreciation for the work of Tom Jensen, Marilyn Dilles, Maryanna Negley, and Kelly Burnett. He stated he would like tonight's meeting to be a celebration but is concerned it will, instead, be a win/lose situation. He summarized that, unfortunately, it was not possible to forge a consensus on the park plan, as was the case with the riverbank stabilization plan. He expressed appreciation for the DPC schedule and noted it is not a short-term solution to the riverfront parking problems, and that solutions must be found somewhere other than through the DPC schedule. He expressed concern about bicycle access to the park area, noting that early park plan discussions included an East-West-North-South integration for bicycles. He noted such integration exists for vehicle traffic but not for bicycles. He opined that the City's bicycle route map implies that the Downtown area is unfriendly to bicyclists. He noted it is difficult to cross the Downtown area in an East-West pattern by bicycle and speculated that the Council will need to spend money in the future to correct this situation. He stated that a bicycle corridor must be incorporated into the riverfront park plan.

Councilor Barlow-Pieterick stated he was impressed by the level of effort invested in the alternative plans presented to the Council and the public. He stated he would not characterize the alternate plans as minor changes to the DRC's plan. He noted that the Council must consider many different issues concerning First Street. He referenced the confirmation that the 20-foot street width in the narrow stretch of the park is a mandatory requirement, if the Council is to accept responsibility for the safety of people along the development. He opined that the Council must "look beyond the obvious," envision future problems, and determine if the Council is being responsible with the safety of the citizens. Given the 20-foot width requirement, he queried the difference between a one-way and a two-way street, opining that a two-way street adds safety because conflicting traffic will slow overall traffic. He referenced previous discussion notes in which the BPAC referred to First Street as a commuter strip and the multi-modal path as a recreational path. He noted that bicyclists expect to share commuter strips with vehicles, and a two-way street would allow bicyclists to share the commuter strip in two directions. He expressed appreciation for the efforts of citizens who prepared alternate plans and encouraged these citizens to become involved in other civic committees. He expressed concern that the Council may not be paying enough attention to other issues.

Councilor Grosch concurred with Councilors Barlow-Pieterick and Tomlinson and expressed appreciation for Councilor Tomlinson's motion. He stated he was encouraged by the questions presented tonight, stating they stress the validity of the proposal presented and give the Council opportunity to proceed in a positive direction. He noted that he has listened to testimony and read materials for some time and given the issue much thought. He concurred with Councilor Barlow-Pieterick that the proposed alternate plans involve major changes. He opined that two questions must be asked before modifications and alternate plans can be accepted: 1) if a major modification was to be made, one must believe that the process was flawed and that the two-way street does not reflect the values of the community and the previous plan discussions; 2) did the information presented to the public concerning the bond fully explain the proposed design features, or, if it did, would the vote have been different. He said he has not been able to answer these questions affirmatively, stating he believed the process was inclusive and exhaustive and that staff and the community have been able to reconstruct the process, so that the process was transparent in nature. He stated he was comfortable with the plans proposed and the comments expressed concerning modifications. He noted that citizens care deeply about the riverfront. He opined there is no reason at present to pursue the alternate plans from citizens, stating they include suggestions that were considered by the DRC. He stated he will support the modifications he expects will be presented. He stated he could adopt the park plan at present.

Councilor Howell referenced 1997 park plan decisions, when he perceived a consensus of an overall global vision for the riverfront, namely, to protect the natural features on the riverbank, create an active place where people would feel safe and comfortable and gather for festivals, and create an active retail strip along the west side that interacted with the park and had offices and residences upstairs. He stated that with time this plan would create a base for people to live and work along the riverfront, helping to support the shops along First Street. He noted the commonality of those desires and the differences in determining how to achieve them. He described the decision-making process as juggling 20 balls at once; while trying to better accomplish one desire, five others were impacted and one was dropped. He noted it was exhausting to obtain the best option to maximize all of the expressed desires. He noted that reviewing the earlier alternatives and decisions helped him evaluate the current discussions. He expressed appreciation for the efforts of citizens who presented ideas to the Council, some of which the Riverfront Commission (RC) had reviewed. He stated he reached conclusions similar to those reached earlier. He opined that maximizing use of the west side of First Street as desired necessitates a 20-foot street width, as long as the information received during December and January concerning stabilization will not impact that street width. Based upon the premise of a 20-feet street, he opined that two-way traffic makes better use of the space. He expressed hope that future demand will be sufficient to warrant public transit and maximize street and park use for festivals when blocks are closed. He concurred that on-street parking is better than adding parking lots because the street then serves a dual purpose. He noted that the original plan reduced parking as much as possible, which was difficult to do while meeting parking standards. He noted the Council removed some parking and gave direction that parking be placed elsewhere. He stated he is not satisfied with some of the new parking locations and may pursue modifications. He noted that parking will be for the benefit of commercial patrons and park users. He opined that on-street parking will create less impervious surfaces in the long run. He stated he liked the park design ideas that evolved and opined that the new plaza designs are improvements, particularly since they preserve trees. He stated he liked the provision of hard surfaces for year 'round park users, the different possible orientations for stages, the path re-located away from the riverbank but where people can view the river, and the proposal for new trees along the riverbank. He stated he would like Council to consider modifications concerning converting to 45-degree angled parking between Monroe Avenue and VanBuren Avenue, resulting in a loss of parking spaces, to gain eight linear feet of park space. He expressed pleasure that the narrower width will apparently accommodate the SFM, opining the importance of multiple uses for First Street. He stated that the reconfiguration of B Avenue and its adjacent parking lot re-locates the street and parking lot farther into the flood plain than he prefers and expressed his preference for alternate plan 4 (Option 4) to move the parking to the south end and add parking to B Avenue between Second Street and Third Street. He stated he would consider bulbed intersections that would give optimum opportunity for sidewalk café space without impeding pedestrian access; he suggested reviewing this design configuration at all bulbed intersections, opining that First Street will accommodate many sidewalk cafés in the future.

Councilor Schmidt expressed his belief that the presentation of the DRC's plan was a "big plus" for the City and for him, personally. He noted he is a "native" of Corvallis and watched First Street develop from an industrial area. He stated that the City bought the riverfront strip of land during 1955, and everything had to move to make way for a street. He noted that 45 years later the plan has not been pursued, the bypass was located on the other side of the river, and the Council is proposing changes to the riverfront. He stated the committees did a wonderful job on the design, with help from staff and the consultants. He opined the project is "big" for the City, noted it has been in process since 1992, and speculated it can be an asset to the City. He noted that the Jackson Avenue plaza fountain will have in concrete an 1853 map of the river commemorating towns which have been lost to floods, such as New Albany, Orleans, and Peoria. He stated he supports the park plan with some revisions or minor changes.

Councilor Wogaman noted he had a great deal of involvement with the riverfront park project and opined the proposed park plan is a good plan for implementation. He stated he supports the plan; although, it may need refinement to mesh with the stabilization efforts and issues presented by the Council. He speculated that the plan has been misunderstood by some citizens. He stressed that the park area will not be a massive parking lot and that the DRC was instructed to move parking toward the ends of the park, if possible, while keeping the parking status neutral. He noted that the DRC reduced parking in the central park area by more than 50% and moved the parking to the ends of the park area. He opined that some parking is necessary in the central park area to accommodate park users and patrons of current and future businesses located in the park area. He stressed that the park area was not created to serve as a through-way or bypass and that the various traffic calming features create a "destination" street. He stated that the proposed park plan will create more green area than is present now and that much of the hard surface will be people oriented and not car oriented. He acknowledged that the plan will be reviewed, and decisions will be made if it must be altered to conform with stabilization issues. He opined that the park plan offers good connection for enjoyment of the river. He noted that the VanBuren Avenue bridge has a separated pedestrian path providing access to the east side of the river. He reported that the RC is working on connecting Shawala Park with Willamette Park via a pedestrian path. He expressed appreciation for the public interest, noting that citizens consider community issues very seriously. He opined that the overwhelming amount of public contact has been very positive and expressed his confidence that the City will have a beautiful park that will be a benefit to the community for future generations.

Councilor Beilstein concurred with Mayor Berg that the park will be "wonderful." He opined that the park plan is, overall, a great project that will improve the City. He stated he especially liked the development between Madison Avenue and VanBuren Avenue, opining it is very attractive and that small commercial enterprises will develop along the park fringe. He stated the plan appears very people oriented. He expressed concern that the attractive business area will not continue to the south because the park area is too narrow. He stated he would prefer a plan that attempted to create a pedestrian mall in the southern portion of the park area and end vehicle traffic at the Post Office and not try to maintain two-way traffic. He expressed his trust that a need exists for connectivity and circulation to justify maintaining a two-way street to Washington Avenue. To save space in the narrow area south of Jefferson Avenue, he suggested reducing traffic to a one-lane, one-way street; however, he acknowledged that little space will be saved with this option because of the Fire Department's requirement for a 20-foot wide street. Alternatively, he suggested combining the bike path and the multi-modal path; although, this option may pose too much danger to pedestrians, and he acknowledged it may be better to keep the two paths separate. He noted that even if parking were eliminated in the southern portion of the park area, most of the area would be paved from the buildings to the riverbank. He stated he would have preferred trying to create a pedestrian mall in the southern area, acknowledging that it may not succeed. He opined that the "Post Office block" is unattractive, not friendly to pedestrians, and serves only as a conduit for Post Office ingress and egress. He stated that the area is too narrow and will only contain pavement. He opined that the area south of Adams Avenue is a potential area for new businesses to develop with orientation toward First Street and the river, but it will never be as attractive as the north end because it will contain so much pavement. He speculated that the block with Mater Engineering may have more possibility for development because it is a more park-like area. He said that Mater Engineering may remove its warehouse, in which case a business could be established with orientation toward First Street and the river. He expressed doubt that the area between Washington Avenue and Madison Avenue will ever be attractive, and stated he doesn't see a possibility for businesses to be oriented to First Street because the area is too narrow to the top of the riverbank. He opined that two-way traffic and on-street parking are great and will fit in the space available to the north, but he is not as optimistic about the success of the southern end of the park area.

Councilor Griffiths noted she began her tenure on the Council dealing with the riverfront and expects to end her tenure on the Council having completed dealing with the riverfront. She speculated the City will have a beautiful plan that people will enjoy. She stated her decisions have been a "battle between head and heart," explaining that her heart "loves" Tom Jensen's plan; but her head, after reviewing data and demographics, says Mr. Jensen's plan won't work in Corvallis at this time. She stated she wants to be sure the City supports the intent of the riverfront bond measure. She opined that no one has pushed a particular point of view solely for personal gain and stated that the dialogue has been beneficial for the most part. She acknowledged that some mis-information has been addressed by the Council. She opined that the Council's job is to weigh all information, regardless of its source. She noted that the Council's decision must be based upon the DRC proposal and its rationale, other data, site visits, and citizen input throughout the process; she continued, stating the decision must be based upon balancing competing interests, interpreting data provided, and values represented, with the final decision, hopefully, representing the best interest of all citizens present and future. She expressed concern about 1) how to maximize the green landscaped areas and preserve the existing trees while still allowing access for people, cafés, and cars; 2) how to minimize potentially costly construction, such as engineered bank stabilization and augured pilings so park features can be over the river rather than setting the features behind the FS line and reducing the cost now and the risk of problems later; 3) how to meet competing interests by improving the commercial environment and the natural environment; and 4) how to make decisions with deliberate speed – not to decide quickly just to end the debate, but not to postpone a decision to avoid the fallout from whatever decisions are made. She noted that no one will be 100 percent happy with the final decision and stressed that the Council needs time to discuss the issues. She stated her other concerns relate to streets and sidewalks. She inquired if there is a way to minimize the parking on the east side of First Street from VanBuren Avenue to Madison Avenue. She also inquired if First Street can be narrowed from VanBuren Avenue to Jefferson Avenue and, if so, can two feet of the former street width be added to the sidewalk width in that area. She expressed concern about handicapped pedestrians being asked to maneuver over two different surfaces. She expressed concerns about parking and the width of First Street between Madison Avenue and B Avenue and the setback and FS line behind the Blackledge Furniture warehouse, stating she does not want to add any features to push the road farther east. She expressed concern about the narrowness of the area between Jefferson Avenue and Washington Avenue, especially the pinch-point behind the Post Office where employees park. She stated she does not want to see extensive fill and stabilization in the area and would prefer that First Street be narrowed to one-way traffic with a drive-up sidewalk. She stated she would prefer that no street exist in this area but acknowledged that may not be a viable option. She expressed concern about First Street between Western Boulevard and B Avenue, noting it seems to be used primarily for parking. She opined that this area is a "prime interface" with the Willamette River, Marys River, and the flood plain and appears to need fill to position the street. She expressed a desire to explore options proposed by citizens and the DRC, along with parking under the Highway 34 bypass at B Avenue and Second Street.

Mayor Berg thanked the Councilors for their comments and recessed the meeting from 9:20 pm until 9:35 pm.

Mayor Berg noted that Councilor Beilstein was taking home his son and would return soon; he returned at 9:36 pm.

Mr. Nelson announced that the DRC requested the Council review three refinements; namely, B Avenue, 45-degree and 60-degree angled parking on First Street, and sidewalks. He noted that other issues were identified during the Councilors' comments concerning the plan.

Mr. Nelson noted that six options concerning B Avenue were presented to the Councilors for consideration during the November 18th meeting. He asked the Councilors for questions of staff or the consultants concerning the proposed options and inquired if enough interest exists for staff and the consultants to pursue a specific alternative option. Mr. Nicholson noted that the table outlining the options includes an indication whether each option is compliant with the Council's plan. He noted that Amendment 11 proposed removing parking from the outside of the B Avenue curve, with the exception of handicapped parking. He noted that this amendment was appropriate at the time it was presented, but the changes in the design for Shawala Park and the skate park were not included in the plan at the time the parking configuration was designed. He noted that the skate park impacts the parking design and poses a query about locating parking on the outside of the street curve for safety reasons.

Councilor Howell expressed his interest in alternative plan 4, noting 1) it maintains circulation on the east side to allow the Ash Building parking lot to develop into other uses; 2) removes parking from the river side, creating a narrower path in the area; 3) moves parking on the south side of the street curve to the outside, creating a narrower profile; and 4) aligns with B Avenue, rather than needing to curve for alignment, providing a better line-of-sight for the intersection. He opined that, in order to accommodate the lost parking, it would be essential to approve 60-degree angled parking on the south side of B Avenue between Second Street and Third Street. He stated that the Council will probably, at a later time, receive for consideration a recommendation from the Urban Services Committee (USC) to re-configure parking on the north side of B Avenue in the same area. He speculated that construction on the south side of B Avenue can probably proceed at this time because it involves City-owned property; as part of this construction, he would like to add a sidewalk connection on the south side of B Avenue between Second Street and Third Street.

Councilor Peters inquired the total number of lost parking spaces under Councilor Howell's proposal. Councilor Howell responded that the original plan contained 43 parking spaces, and Option 4 had 18 spaces, for a loss of 25 parking spaces. He noted that 19 parking spaces will be available on B Avenue, which Mr. Nicholson confirmed were originally counted as "parking neutral." Councilor Howell stressed the importance of considering the parking spaces on B Avenue when determining the needs for the skate park and basketball court, along with other park users. He acknowledged this option would cause a reduction in parking but opined it would be a better trade-off than expanding parking into the park area. He noted the major value of locating parking away from the flood plain and reducing the width on the river side of the loop. He stated he favors Option 4 with other re-striping plans for neighboring areas as presented to the USC. He noted the re-striping plans are "tabled" while staff conducts outreach to the property owners because the re-striping plans will involve removal of parking strips in several blocks. He noted that some curb cuts in the area may make angled parking less desirable, but the south side of B Avenue could probably be re-configured.

Mr. Nelson clarified that the programmed widening is separate from the riverfront park project. He noted that Councilor Howell's proposal would involve building sidewalks and 19 60-degree angled parking spaces.

Councilor Peters noted that, during Council discussions, the number of parking spaces has changed and inquired the number of spaces in Option 4 and the number of spaces currently existing. Mr. Nicholson reiterated that the consultants strived to keep the park plan parking neutral. He stated that the concept master plan contained 619 spaces, which is also the number of spaces currently existing. He explained that the 619 spaces includes off-site improvements. He noted that the north and south parking lots contain a total of 560 parking spaces and that 57 parking spaces were obtained by reconfiguring adjacent streets.

Councilor Tomlinson inquired if Option 4 aligns B Avenue at Second Street; Mr. Nicholson confirmed and acknowledged that page 51 of the "green" handout should indicate that B Avenue aligns at Second Street.

Councilor Beilstein noted that Option 4 shows parking between the multi-modal path and B Avenue and inquired what constraints determined ending parking where indicated on the diagram. Mr. Nicholson explained that opportunity exists to add more parking spaces, but a trade-off exists with routing the multi-modal path through the existing cottonwood trees.

Councilor Peters referenced a criteria used in the original design, noting a clearer visual path was desired for people traveling south on First Street, thus, parking was moved from the outside of the curve to the inside of the curve. He acknowledged that parking could be extended along the curve and was considered during various plan reviews. He stated that the proposed parking lot is somewhat larger than was originally considered.

Councilor Wogaman stated he supports Option 4, noting it is close enough to parking neutrality if additional parking can be found elsewhere. He stated it is important to add spaces to service the basketball court and skate park under the Highway 34 bypass.

Councilor Tomlinson stated he supports Option 4 if Council can examine parking on B Avenue between Second Street and Third Street, noting the matrix indicates a decrease in capital cost with this plan and suggested using the difference to fund the programmed widening and angled parking for B Avenue between Second Street and Third Street. Mr. Nelson responded that staff would need to confirm with bond counsel that this would be an appropriate use of the bond funds.

Councilor Peters stated he favored Option 3 because of the parking issue, stressing the importance of maintaining as much parking as possible because of the loss of parking in other areas of the park. He expressed concern about reducing parking in one area and not finding parking in another area. He stated he could accept Option 4, if it was supported by a majority of the Council, but he preferred Option 3, opining it uses space effectively. He opined that, because of park uses, it is sensible to put parking at the south end of the park.

Councilor Griffiths stated she preferred Option 6 with no street and no parking. She noted that the area bordered by Second Street, B Avenue, and First Street is already pretty full of parking. She opined there would be less impact to put more parking in that area, rather than the layout proposed in Option 4. She expressed her desire to get away from the Highway 34 bypass and have a viewscape and path away from traffic. She stated that she would choose Option 4 or Option 3, but she would like to hear more comments from Councilor Howell concerning his choice of Option 4. She noted that Options 3 and 4 are very similar, but Option 4 seems to locate parking farther into the area needing fill.

Councilor Howell stated he was motivated to reduce the width on the east side of the park. He noted he started his review with Option 6 and tried to incorporate other issues. He opined that Option 4 (versus Option 3) does not require the street to swing out as it passes the riverside and breaks at a later point. He stated his preference to locate the street as far west as possible and noted the street aligns with B Avenue.

Councilor Beilstein noted that the loop connecting B Avenue to Western Boulevard does not provide access to anything and only provides parking. He stated he would like to maximize the parking along the loop, explaining he does not like having the street in that location without parking along it. He stated he would prefer parking on both sides the length of B- Avenue. He inquired the purpose of having the street if parking is not optimized. He noted that, other than parking, traffic cannot access anything from the loop entrance that cannot also be accessed from Second Street.

Councilor Barlow-Pieterick shared Councilor Beilstein's opinion, noting the street value is reduced without parking. He stated that Option 4 is good, but he might choose 3 because of its parking configuration. He expressed uncertainty about having parking the length of the street and still accommodate the area with the missing tooth.

Councilor Howell explained that accommodating the street on the east side allows circulation without a lot of back and forth movements, thus providing some safety. He speculated that it will allow future use of the Ash Building site. He noted that the riverfront plan involved not having parking lots along the riverfront but having structures with first-level people-oriented activities. He speculated that the area will develop in the future and that activity should develop toward the river, which he believes will occur more fully with a street as frontage. He noted he struggled with the idea of not having a street and having a cul-de-sac on Western Boulevard but did not like either idea, noting the cul-de-sac interrupts pedestrian flow and impedes efforts to make the area attractive.

Councilor Barlow-Pieterick speculated that future discussions concerning motion amendments may involve reducing parking spaces. He stated that putting parking at the south end of the park area may be of low value, noting that people may not use the parking lot as much as the City hopes. He suggested keeping parking as a pending issue through ensuing discussions.

Councilor Wogaman requested keeping open the option of extending parking. If the parking lot being used by the Ash Building develops, the surrounding streets may provide better parking options, so the building will not need to face away from the river. He opined this potential would be facilitated by extending the street through the park area.

Mr. Mann clarified that there are currently 619 parking spaces along the riverfront. He stated that the conceptual park plan retains all 619 parking spaces. He stressed that the plan is "conceptual," explaining that the City will not be able to achieve all the on-street parking with the initiation of the park plan because of existing curb cuts and other conflicts. He stated that the DRC looked for places to replace the lost parking spaces in the general vicinity of the Downtown area and included recommendations in the park plan. He noted that the bond measure addressed the issue of doing some off-site parking improvements to maintain parking neutrality for the park. He noted the proposed improvements include angled parking on Second Street between Washington Avenue and Western Boulevard. He stated that angled parking on both sides of B Avenue between Second Street and Fifth Street was included in the plan but requires outreach to property owners because of necessary street widening. Reconfiguration of parking along Washington Avenue between Second Street and Fifth Street is also planned to help maintain parking neutrality for the park. He noted that no additional parking is available in the Downtown area without additional construction improvements.

Mayor Berg commented that other value issues may change the parking neutrality issue.

Councilor Griffiths noted that parking neutrality was a goal that is important to remember. She noted that the City would gain 57 parking spaces with additional work on future curb cuts. Mr. Nicholson clarified that the 57 parking spaces would be gained over the long-term development of the park. Councilor Griffiths asked when the 57 parking spaces might be gained. Councilor Barlow-Pieterick commented that some parking spaces may not be gained until buildings are developed and adjacent curb cuts are removed. He noted that curb cuts account for 20 parking spaces and that parking spaces were lost along First Street in the narrow area and in the loading area behind Blackledge Furniture. Mr. Nicholson clarified that 49 of the 57 lost parking spaces are attributed to curb cuts.

Mr. Nelson stated that another option was discussed by the Capital Improvement Program (CIP) Commission and will be referred to the Council; namely, if Downtown development does not provide opportunities for increased parking, the City would impose irrevocable consents from the developers to participate in future parking improvements. He suggested that the Council may want to consider a similar proposal for the park plan project.

Councilor Griffiths inquired if Option 4 will impact the restroom location. Mr. Nicholson responded that the restroom is proposed for the intersection of Second Street and B Avenue.

Mr. Nelson stated that Mr. Nicholson distributed a document at the November 18th meeting concerning the base plan and the alternative plans. Among the alternative plans was a comparison of 45-degree and 60-degree angled parking along First Street. He noted that the street width would change if the degree of angled parking is changed. Once the width is determined, there is no flexibility, short of major investments, to revert to 60-degree angled parking.

Mayor Berg noted the issue involves, as values, a net loss of parking spaces, an additional eight feet of street width, and future flexibility.

Councilor Tomlinson referenced the comparison of 45-degree versus 60-degree angled parking for First Street and asked if the 8-foot loss of street width would be gained in the sidewalk. Mr. Nicholson responded that the eight feet would be taken from parking stalls on either side of the street, resulting in the centerline of the street being moved four feet closer to the buildings. He explained that this change would cause a misalignment of First Street at VanBuren Avenue. Councilor Barlow-Pieterick noted that the diagram does not reflect the change in street width. Councilor Tomlinson asked if this change would result in eight more feet of green space, rather than a narrower street and a wider sidewalk. Mr. Nicholson stated that eight feet of impervious surface would become green space.

Councilor Barlow-Pieterick inquired if this plan would allow increasing the sidewalk by two feet to a total width of six feet. Mr. Nicholson responded that a wider sidewalk may be possible but cautioned that a change in the sidewalk width is also driven by the SFM and the ability of the SFM vendors to sell from their vehicles and still have people pass the vehicles.

Councilor Peters noted that the park plan was presented November 18th and opined that some interested parties have not had time to state their positions in response. He stated he was uncomfortable voting on the plan without further information and said he would like to have more time to consider the issues. He stated he needed enough time to make a proper decision concerning a multi-year process. Councilor Griffiths expressed sympathy for Councilor Peters' position but stated she would like to work until 11:00 pm and assess the Council's position at that time. She opined that the Council is not ready to consider motions or make decisions and is considering alternatives, trade-offs, and values. Councilor Peters concurred but stated he expected a motion would be presented and expressed concern about its timeliness.

Mr. Zilis reviewed two diagrams for sidewalk cafés. He noted that the standard sidewalk is 15 feet wide, part of which would be composed of paver blocks, lights, and trees. A standard sidewalk would have eight feet three inches for dining with a barrier and still meet the requirements of a three-foot clear walkway and a six-foot setback. He noted that discussions concerned re-locating handicapped parking spaces from the diagram location marked "tree pit" to eliminate a curb drop. The alternative plan contains a sidewalk of the same width, but the bulbed area is composed of paving and allows additional dining. The alternate plan eliminates one parking space.

Mr. Nelson inquired how many intersections would be affected by the proposed alternate plan; Mr. Nicholson responded, three – Madison Avenue, Monroe Avenue, and Jackson Avenue.

Councilor Wogaman inquired if the alternate sidewalk plan can be applied to both sides of the intersections. Mr. Zilis responded that another option would involve applying the alternate plan without the plant material and allow the extra paved space, regardless of the business located at the intersection.

Councilor Beilstein requested clarification on the location of the pedestrian walkway in relation to the dining tables. He noted that the area is public right-of-way and that the City has allowed Fox and Firkin and other restaurants to use public rights-of-way for sidewalk seating. He inquired if a Council or City policy exists for rental of the public right-of-way. Mr. Nelson responded affirmatively, explaining that the City assesses a flat fee. Councilor Howell commented that the fee was, essentially, a processing fee of approximately $50 for non-alcohol-related uses and $100 for alcohol-related uses. Councilor Beilstein opined that the City is providing an accommodation to commercial businesses and that it would be reasonable for the City to charge a fee for use of the sidewalk, noting it provides an advantage to the affected businesses.

Councilor Schmidt stated he favors the typical sidewalk dining layout, opining that this layout would be fair to other businesses farther along the street. He commented that, even though the City could rent the space labeled on the diagram as "planting bed," he would prefer putting flowers in the planting beds.

Councilor Grosch stated he favored the typical sidewalk plan, and expressed concern that applying an alternate plan to three intersections could set a precedent for future development at those and other intersections. He inquired if the City could incorporate into development charges any reconfiguration required for a future property developer wanting sidewalk dining. Mr. Nelson responded that once the sidewalk is constructed, a restaurant applicant could request Council approval to convert a planting bed to a sidewalk café enhancement. He stated the Council would need to determine if a planting bed should be converted for the benefit of a for-profit business.

Councilor Howell requested clarification of the standard and alternate sidewalk diagrams. He noted that the "typical" diagram was a modification of previous diagrams and expanded and covered the handicapped access area with a larger planting area than was included in the original design. Mr. Nicholson responded that the planting area is the same size, but the handicapped parking space and access were moved farther south. Councilor Howell noted that Landscape L2.5 diagram showed a smaller planting space than in the alternate plan diagram. Mr. Nicholson responded that the consultants intended to keep the planting area the same size.

Mr. Nicholson clarified that the expanded sidewalk area is only applicable on the south side of the three identified intersections and cannot be equally accommodated on the north side of the intersections because of the proposed angled parking.

Mayor Berg re-stated that a typical sidewalk layout or planting bed could be converted to a dining area.

Councilor Peters requested clarification concerning an earlier comment by Councilor Griffiths; namely, if parking is changed to 45-degree angled parking, resulting in gained space, can the sidewalk width be increased. Councilor Griffiths responded the issue is a concern but stated the conflict for handicapped access does not exist in either the typical or alternate sidewalk layout. She noted that the diagram showing a tree pit would cause a pedestrian to circle the tree pit to re-access the sidewalk. She questioned the measurements cited in the diagrams. She stated she would like to leave open as many options as possible; and expressed uncertainty about asking pedestrians to walk through a sidewalk café.

Councilor Grosch concurred with Councilor Griffiths concerning the sidewalk dining alternative layout. He questioned possible conflicts with servers, diners, and pedestrians and potential congestion issues. He speculated that the design contains inherent problems that should be avoided.

Councilor Howell noted the planting area is smaller than at other intersections because of curb cuts at the other intersections that prevented insertion of parking spaces. He stated he would like to equalize the planting areas among the intersections. He inquired if allowing 45-degree angled parking on the east/west streets would allow a larger planting area on the north side of the intersections. He stated he does not want the sidewalk to pass through the café, and he likes the planted area that will improve the aesthetics of the cafés. If the sidewalk is widened overall, the café would be bigger; but the clear area would not be increased, unless the sidewalk standard was changed. Councilor Barlow-Pieterick noted that a six-foot walkway could be achieved by moving the curb, rather than the trees or light standards; however, car overhangs would present obstacles. Councilor Howell expressed reluctance to widen sidewalks because of the Council's efforts to increase park space. As a compromise, he stated he would consider reducing the planting area and allowing the café to bulge on one side but expressed his preference for keeping pedestrians out of the dining area. He stated he supports continuing with the plan with some enlargement of the planting area at the Madison Avenue intersection.

Councilor Beilstein noted that the typical sidewalk layout is not acceptable to Fox and Firkin, which prompted the Council to consider alternatives. Councilor Howell confirmed that he considers the cobbled area to be similar to the sidewalk, his understanding that the type of pavers should be ADA compliant, and that the installation method should ensure that the pavers remain level. Councilor Beilstein stated that the three-foot clearance could be met, if the full width of the paver area was available, noting that problems are caused by tree pits and plantings. He inquired if the tree pits and plantings could be move closer to the curb. Mr. Zilis responded that the tree pits and plantings are set back to accommodate car overhang. Councilor Griffiths inquired if a tree is necessary and if there are areas where the trees can be sacrificed since a large planter area is available.

Councilor Wogaman stated the Council should try to encourage the type of sidewalk businesses currently located along First Street. He suggested moving the tree pit ten feet south and then beginning the spacing pattern. He noted that moving the barrier to the edge of the sidewalk would allow some space in the dining area. He stated he supports the increased-seating goal of the alternative but foresees problems with servers, diners, and pedestrians.

Councilor Peters noted that barriers will be installed by property or business owners and that the Council is treating the barriers as permanent fixtures. He opined that the barriers can be moved more easily than the trees.

Mr. Nelson referenced the comparison of 60-degree and 45-degree angled parking and the third page of Mr. Nicholson's November 18th memorandum. He noted that the parking on the east/west streets will be a combination of 60-degree angled and parallel, according to the original plan, but will be 45-degree angled, according to the alternate plan. He noted that the total number of parking spaces remains 77 and is accommodated within the existing street width, but the stall length and street width are reduced.

Councilor Howell responded that, overall, he likes the change in terms of its impact on the street appearance. He expressed uncertainty about Jefferson Avenue and the amount of east-bound traffic at the Post Office, noting that the traffic could probably be better accommodated with a greater number of parking spaces being located on the south side of the street. He noted that the current design has 19 parking spaces on the south side of Jefferson Avenue. Mr. Peterson confirmed that 60-degree angled parking would accommodate 19 parking spaces on the south side of the street, versus 15 parking spaces with 45-degree angled parking. Mr. Nicholson noted that angled parking on the north side of the street provides quicker ingress and egress than does parallel parking.

Councilor Peters noted that changing angled parking from 60 degrees to 45 degrees results in a parking space length reduction from 18 feet to 14 feet and lane width reduction from

14 feet to 12 feet and inquired why the total street width remains 52 feet. Mr. Peterson responded that the 60-degree angled parking plan involves parallel parking on one side of the street.

Councilor Beilstein expressed concern about the area between Western Boulevard and Washington Avenue. He noted that, because of the slide, a significant area is open to the river without vegetation. He stated he would like to relocate the overlook planned for Washington Avenue to the slide area and take advantage of the lack of trees.

It was moved and seconded to continue the meeting to 11:30. The motion passed 5 to 4 on the following roll call vote:

AYES: Schmidt, Wogaman, Tomlinson, Barlow-Pieterick, Howell
NAYES: Peters, Beilstein, Griffiths, Grosch

Councilor Griffiths stated she was beginning to resent the Mayor's repeated requests for a motion on the floor. She acknowledged the passion and the sense of urgency to resolve the procedure. She stated she would prefer that the Council be allowed to work through the procedure.

Councilor Howell speculated that a proposed motion would be followed by amendments. He stated he would like to accomplish as much as possible tonight and suggested identifying any possible amendments that could be completed tonight and then table and identify any other information needed for other amendments. He suggested completing tonight the issues of 45-degree angled parking on theEast-West streets, possibly the issue of B Avenue or 45-degree angled parking on the north end of First Street. He opined that the bulbed intersections would require more information and should be addressed later.

Councilor Peters expressed concern about a tour of the riverfront. He noted that it would be easier to move forward if the Council knew that the map was correct; if the map is incorrect, he would consider other options in the narrower areas. He stated that his future amendments to any option would result from a tour of the riverbank and any information derived from it. He stated that he would move to table any motion that requested acceptance of the park plan as presented. He reiterated that, except for decisions concerning the East-West streets, he cannot make a decision tonight concerning acceptance of the park plan. He noted that almost all other options presented impact parking. He opined that "next steps" must be determined before the Council can make a decision concerning acceptance of the park plan.

Councilor Barlow-Pieterick referenced earlier comments that issues would be presented other than those presented by the DRC; he commented that he had not yet heard the other issues. He opined that the issues should be discussed tonight, rather than at a later meeting. He suggested scheduling another meeting, rather than using the next regular Council meeting. Councilor Griffiths agreed with stopping at some point and determining the next step. Councilor Howell noted that scheduling the next meeting is impacted by whether Councilors want information from staff and/or the consultants, want to participate in a walking tour of the riverfront, or want to review other options.

Councilor Griffiths cited problems behind Mater Engineering and a need to address conflicts in the area and whether modifications can be made to deal with the conflicts. She noted that the sidewalk is very straight, and the multi-modal path is very close to the sidewalk. She stated she would like to consider alternatives for that block, one being a possible combination of the sidewalk and the multi-modal path.

Councilor Barlow-Pieterick noted that the Council requested the sidewalk be extended the length of the park for continuity and connectivity with Shawala Park. He stated he would not favor a motion for more information concerning this issue. He referenced the DRC's decision concerning the sidewalk relevant to the graffiti wall, which would use a six-foot stretch of paver blocks to identify an artist area. He requested input from other Councilors whether they considered the decision to be good. He opined that some issues in the park plan are being overlooked, and time is being spent on issues that are not relevant.

Councilor Howell stated he struggled with issues of removing existing vegetation to align the sidewalk and considered options. He stated he does not favor eliminating the sidewalk because the sidewalk and the multi-modal path serve different purposes, and he doesn't want people walking the sidewalk during the evening to have to wander in the dark to find the path. He stated he considered options for meandering the sidewalk around vegetation, but deemed them unsuitable. He noted that the proposal to add vegetation between the multi-modal path and the sidewalk seemed superior to trying to meander the sidewalk and connect it with the sidewalk located on the other side of Western Boulevard. He stated he is satisfied with the plan and opined that designating a portion of the sidewalk for the grafitti wall was a good decision.

Councilor Beilstein inquired about the accommodation for the grafitti wall. Councilor Barlow-Pieterick responded that six feet along the wall will be surfaced with paver blocks instead of concrete. Councilor Beilstein stated he would prefer making the area designation clearer and suggested use of an absorbent surface, such as grasscrete. He stated that Margaret Puckett would prefer the graffiti wall stay as it is. He noted that the building won't always exist and the grasscrete or pavers could be replaced with concrete in the future.

Councilor Wogaman stated he valued the sidewalk and noted that pavers were agreed upon as a medium for designating the graffiti wall area. He stated he would like to keep the sidewalk.

Councilor Griffiths stated she is not opposed to the sidewalk, but she is opposed to the insistence that every sidewalk be absolutely linear and absolutely straight. She opined that it must be possible to meander the sidewalk among the vegetation. She stated she would like to look at options.

Councilor Tomlinson referenced a memorandum from the City Manager to the Council concerning motions having contingencies about bond counsel opinions and riverbank stabilization. He stated that the Council may have to decide issues related to cost versus benefit, such as the cost of putting a plaza on pilings versus pulling back the plaza to get it behind the FS line. He inquired if the City is providing amenities that may be too expensive. He suggested that the motion to adopt the park plan should contain provisions to examine cost/benefit issues. Councilor Howell suggested the motion contain a clause concerning the bond counsel and riverbank stabilization. Mr. Nelson stated that everything discussed can probably be accommodated within the budget, or staff will return to the Council concerning budget and cost factors. Councilor Peters noted that if the entire project is within the budget, the Council must still determine if certain factors are more costly than their potential benefits. He suggested a cost breakdown of the features.

Mayor Berg suggested November 29th for another meeting to continue discussions concerning the riverfront park plan. Councilor Howell concurred with November 29th and requested information to look at routing the sidewalk around vegetation near Mater Engineering. Mr. Nicholson responded that the designs are completed and were reviewed by the DRC. He noted that he will facilitate a Peer Review Group meeting November 29th, but Mr. Zilis and Mr. Peterson would be available to the Council. Mr. Nelson noted that Mr. Mann will also be unavailable.

Councilor Wogaman noted that the Council is not in a position to make a decision tonight and scheduled another meeting. In response to Mayor Berg's earlier requests, he presented the following motion:

"That the plan presented by the DRC and the consultants be adopted, subject to changes indicated by the bank stabilization study, alternatives included with the DRC report, and suggestions of individual councilors following fact-finding inquiries in the near future. This adoption is also subject to review of the City Attorney and bond counsel."

The motion was seconded.

Councilor Barlow-Pieterick expressed concern regarding the alternatives presented by the DRC. Councilor Wogaman responded that the adoption would be subject to decisions concerning the DRC's alternatives and concerns of individual Councilors.

It was moved, seconded, and unanimously passed to table the motion until the November 29th meeting.

Councilor Peters requested a walking tour of the riverfront. Mr. Nelson suggested November 29th at 3:00 pm. Notice will be published. The next meeting will be held November 29th at 7:00 pm. Tour participants will meet in the south parking lot.

Mayor Berg stated that the Council will consider during its next meeting a motion to adopt the DRC's park plan, proceed with amendments, and ultimately adopt an amended motion.

Councilor Howell cautioned tour participants to not park in the south parking lot, as it is a permit parking lot.

XI. ADJOURNMENT

The meeting was adjourned at 11:29 pm.

APPROVED:

MAYOR

ATTEST:

CITY RECORDER

EXHIBIT B

Floodplain Impacts

(CH2M Hill)

MEMORANDUM **CH2MHILL**

Corvallis Riverfront Commemorative Park and Riverbank Restoration

WRG 00-0002 Floodplain Impacts

TO: Greg Winterowd/Winterowd Planning Services

FROM: Dan Peterson/CH2M Hill

DATE: August 22, 2000

This memorandum responds to Mr. Mater's August 16th testimony, regarding the net floodplain impacts resulting from riverfront park and parking lot development. Exhibit 2 to our first "Response Memorandum" addressed this issue. In summary, the design of the multi-modal path and B Avenue extension to Western Boulevard attempted to balance the cut and fill, by matching existing ground contours as much as possible. This was almost achieved – with only 40 cubic yards of excess fill. We noted that this small net fill was more than offset by the south parking lot (constructed under WRG 99-3), which resulted in 2,100 cubic yards of cut.

However, following submission of Exhibit 2, the Mr. Mater commented that the south parking lot "cut" was inappropriately used to offset north parking lot fill, and should not be counted twice. While it is true that we did not account for north parking lot fill in our calculations, this does not change our conclusions with respect to the balanced cut and fill objective.

The north parking lot, constructed under the CSO pipeline project (WRG 99-3), had 400 cubic yards of net fill. The 400 cubic yards of fill in the north parking lot was more than offset by the 2,100 cubic yards of cut in the south parking lot – resulting in a net cut from north and south parking lot construction of 1,700 cubic yards. Therefore, accounting for the both parking lots, and the current proposal, the net effect for the entire riverfront project is an increase in floodplain volume of appoximately 1,660 cubic yards. This supports Mr. Winterowd's rebuttal testimony on August 16th.

Mr. Mater also stated that the floodplain impact analysis done for the WRG 98-2 riverbank stabilization permit did not account for trees and native vegetation along the riverbank that will now be preserved. The 1998 riverbank stabilization project relied on reconstruction of the riverbank – and removal of virtually all trees along the riverbank. The 1998 floodplain analysis evaluated the effect of significantly changing the landscape of the riverbank from "tall, dense and stiff vegetation" to "short, sparse and pliable" vegetation. This analysis concluded that "the impact of the project on water surface elevations will be negligible to a reduction of a few tenths of a foot, depending on the stage".

In conclusion, after considering floodplain storage impacts from the north and south parking lots, as well as the current proposal, 1,660 cubic yards of material will be removed from the floodplain. This will increase flood storage capacity proportionately. Retaining existing riverbank vegetation will have a negligible impact on this conclusion. The balanced cut and fill objective will be achieved. Thus, it can be seen that the proposed project has "minimal adverse effect" on the floodplain as stated in the WRG criteria.

EXHIBIT C

Shear Piles and Impacts to Riparian Trees
(CH2M Hill)

Corvallis Riverfront Commemorative Park and Riverbank Restoration

WRG 00-0002, Shear Piles and Impacts to Riparian Trees

TO: Greg Winterowd/Winterowd Planning Services

FROM: Dan Peterson/CH2M Hill

DATE: August 22, 2000

At the WRG public hearing on July 16th, public testimony questioned the use of concrete shear piles along the top of the bank and the impacts they may have on riparian trees. Questions were raised regarding the stability analysis, the contribution of tree roots on stability, and impacts to tree roots.

Let me provide some background on how the shear pile wall design evolved. In October, 1999, after considerable public input, the City Council elected not implement the bio-engineered solution to stabilize the riverbank to prevent the removal of riparian trees. The Council directed the design team to develop a new solution to minimize the loss of trees. A joint CH2M Hill/OSU team was formed to look at different alternatives. At the same time, the Mayor appointed a Peer Review Group (PRG) to review the riverbank stability. The PRG consisted of ten individuals; professors, hydrologists, geomorphologists, stream and riparian ecologists and professional engineers from CH2M Hill, OSU, U.S. Army Corps of Engineers and the U.S. Forest Service.

The PRG concluded that the methods and parameters used to perform the geotechnical stability analyses and Geotechnical Stability Line (GSL) were "consistent with the standard practice of engineering". It should be noted that the PRG charter was to review the methodology for the establishment of the GSL and recommend changes in the methodology and changes in the location of the GSL, if appropriate. Selection of a stabilization method was not part of the PRG charter. See Exhibit D, Rebuttal Comments Addressing Geotechnical Slope Stability and Stabilization of the Riverbank Using Pilings for additional information. A copy of the conclusions of the PRG Report is attached to this memorandum. One copy of the entire PRG Report is included and can be downloaded from the City of Corvallis' website at www.ci.corvallis.or.us.

In November, 1999, the CH2M Hill/OSU team began looking at the redesign of the riverbank restoration. The recommended solution presented to City Council consisted of ecological restoration north of Madison Avenue and a combination of mechanical stabilization and ecological restoration south of Madison Avenue. At this time CH2M Hill investigated various methods of stabilization and discussed them with OSU. Drilled concrete piers and micropiles were selected as the method of stabilization that would have the least impact on existing riparian trees. These methods were discussed in detail and guidelines were developed on which methods to use in proximity to existing trees, precautions, risks and construction techniques. The OSU team concluded that drilled piers and micropiles was the best method of stabilization.

At the January 6, 2000 City Council meeting, the City Council voted to implement the plan of using mechanical stabilization of the riverbank south of Madison and ecological restoration of the entire riverbank. At the March 6, 2000 City Council meeting, the OSU team submitted a two-page memorandum summarizing the ecological risks and potential impacts to riparian vegetation imposed by shear piles and micropiles. The memorandum (attached) addresses wound pathogens, root damage, and construction damage to trees. The conclusion reached by the OSU team was "the most likely outcome is that two or three trees that are currently in poor-to-fair condition will die within a few years of construction activities and have to be removed".

The issue of bank stability analysis and the GSL has been fully analyzed and accepted by the PRG and the issue of tree and root impacts by the drilled piers and micropiles has already been addressed by the OSU team. This should address any concerns brought about during the public hearing on August 16th.

Riverbank Stability Analysis Peer Review

for the

Corvallis Riverfront Project

Report to the Corvallis City Council

January 3, 2000

Peer Review Group:

Stan Gregory, Oregon State University, co-chairperson
Gordon Nicholson, CH2M Hill, co-chairperson
Don Anderson, CH2M Hill
Dave Bella, Oregon State University
Bob Beschta, Oregon State University
Craig Fischenich, U.S. Army Corps of Engineers
Gordon Grant, U.S. Forest Service
Boone Kauffman, Oregon State University
Pete Klingeman, Oregon State University
Marvin Pyles, Oregon State University

Key Technical Support:

Vince Rybel, CH2M Hill
Jaco Esterhuizen, CH2M Hill

CONCLUSIONS OF THE PEER REVIEW GROUP

The following section presents the final conclusions of the Peer Review Group (PRG) that evaluated the technical validity of the geotechnical stability analysis conducted by CH_2M-Hill and the resulting location of the Geotechnical Stability Line (originally referred to as the Factor of Safety Line in report to City Council on December 6, 1999). The group assessed its consistency with the standard of practice in the discipline. The group examined the parameters used in the analysis, plausible ranges for critical parameters, and the need for other possible parameters in the analysis. The report that follows the Conclusions section explains the details of the analyses and the group's deliberations.

Conclusion 1:
The group concluded that the methods used to perform geotechnical stability analyses, parameters used in the analyses, and the resulting determination of the Geotechnical Stability Line are technically valid and are consistent with the standard of practice in engineering.

The PRG evaluated the scientific and technical basis for the geotechnical stability analysis and for the location of the resulting Geotechnical Stability Line, as well as its conformance with the standard of practice. The group examined the parameters used in the analysis, plausible ranges for critical parameters, and the need for other possible parameters in the analysis. Though additional factors are relevant to the riverbank stability and should be considered by the city in the future, the modified Geotechnical Stability Line serves as a valid and useful framework for making long-term decisions about the Corvallis riverfront.

Conclusion 2:
The analyses incorporated a range of relevant factors, but it is not a true "worst case" or "best case" analysis. It represents a range of plausible estimates.

The Geotechnical Stability Line was determined for current conditions, which include toe-slope erosion protection from the existing riprap. Variation in soil strength, water levels, reinforcement from tree roots, and elevation of the riprap toe-slope protection result in a geotechnical stability "band" rather than a single line. The Stability Line is midrange in the band, but not necessarily exactly in the center of the band due to the relative weight of individual factors in the stability analysis.

Conclusions 3:
The location of the Geotechnical Stability Line (determined in the original analysis) should be shifted 1 ft to 2 ft to the west; closer to the center of the east and west limits of the "band".

The position of the Geotechnical Stability Line varies locally with respect to the top of the riverbank as a function of slope steepness and height. The location of the Stability Line from the bank crest ranges from approximately 10 ft at the downstream north end of the park (lower and less steep banks) to approximately 20 ft at upstream south end of the park (higher and steeper banks).

In contrast, the position of the stability line with respect to the property line on the west side of First Street varies from about 40 feet east of the property line at Jefferson Avenue to about 185 feet east of the property line at the north end of the project. This variation in distance of the Stability Line from buildings along First Street is directly related to the current proximity of the river to the First Street property line and bank steepness and height.

Space between the First Street property line and the Geotechnical Stability Line can be considered to be an area in which selected park elements (e.g., utility lines, sidewalk, street or bike-path, parking, river-front walking path, park structures) could be included without the need for stabilizing measures. This area includes Stability Zone 3 and part of Stability Zone 4 shown schematically in Fig. 2a.

Conclusion 4:
Though the model projections cannot precisely define the location of the Stability Line, the series of cases examined by the group indicate that shifts of only a few feet can involve relatively large changes in the factor of safety.

Conclusion 5:
Space for improvements is not limited by the Geotechnical Stability Line north of Madison Avenue, but space for improvements generally is limited between Western Avenue and Madison Avenue (not based on any specific plan for the Park).

The location of the Geotechnical Stability Line and the methods used to determine its location do not dictate a particular riverfront development plan. An array of options exists for the Corvallis riverfront (e.g., sidewalk, street, bike-path, parking, river-front walking path, streets, plazas, park structures, open-space, riparian forest). However, some of these options may require stabilization measures or changes in park design to meet the current standard of practice in geotechnical engineering. The Peer Review Group has not considered particular stabilization measures and the pros and cons associated with them. Selection of one development plan versus another is a value-based decision that will carry with it various financial, aesthetic, utilitarian, and ecological benefits and costs.

In responding to the city's request, the Peer Review Group assumed that final decisions had not been made and that the City Council will consider a full range of actions for riverbank management and park design based on the information provided by the stability analysis and peer review of the methodology.

In areas limited by available space east of the Geotechnical Stability Line, two major types of action are available to the city. One type of action that addresses limitations created by riverbank stability includes actions that shift the location of line through active stabilization of the riverbank. A different type of action that also addresses limitations created by riverbank stability is modification of the dimensions or locations of improvements so that they are not placed between the crest of the riverbank and the Geotechnical Stability Line.

Stabilization efforts could make the bank more stable and move the Stability Line east toward the bank crest. These actions would allow a higher level of development in areas with limited space than would be possible without stabilization and is more compatible with existing riverfront plans. However, such efforts would incur additional financial costs, monitoring requirements, and losses of ecological function. In addition, the city could incur additional repair costs to park improvements if unanticipated factors cause failures in stabilized reaches.

Alternatively, moving improvements away from the bank crest and to the west of the Stability Line or reducing their dimensions would maintain green space, environmental values, and not require additional construction and expenditures. Small shifts in location of improvments result in significant changes in potential risk. However, potential improvements for the riverfront area would be limited or reduced. This action would require alterations of current development plans. Economic costs and ecological impacts would be reduced.

Each approach can be utilized to varying degrees along the riverfront. Our report should not be represented as favoring either type of action because the group did not study either of them. As a group we are neutral on such actions.

Conclusion 6:
The location of the Geotechnical Stability Line can shift in the future as a result of natural processes or stabilization measures.

The Geotechnical Stability Line is based on current conditions. Stabilization measures for reducing the potential for slope failure will have the effect of moving the Stability Line toward the river. Future natural changes to the riverbank can also move the Stability Line. Local slope failures and erosion of either the existing toe-slope riprap or the riverbank above the existing riprap can have the effect of moving the Stability Line away from the river. Measures taken to prevent or repair future slope failures and bank erosion can maintain the location of the Stability Line. The city will need to have some type of monitoring and repair program to maintain existing conditions. A long-term riverfront management strategy is needed to guide future actions.

Conclusion 7:
Other relevant factors potentially affect the riverbank zone of stability. The Peer Review Group did not have sufficient time to fully analyze these factors or reach conclusions.

Other factors related to riverbank dynamics that were identified and discussed by the group include changes in historical and future river flow patterns, landform changes affecting flood hydraulics, bank erosion rates, prior upstream filling and riprap placement, influences of riverbank vegetation, and City stormwater practices. In the future, the city may want to evaluate or monitor several of these factors.

Corvallis Riverfront Bank Stabilization and Ecological Restoration Plan
A Summary of Ecological Risks and Potential Impacts to Riparian Vegetation Imposed by Shear Piles and Micropiles

Presented to Corvallis City Council and Mayor Berg
By Kathy Staley, Kate Dwire, Jack Brookshire, Stan Gregory, and Jim Hall
March 2, 2000

Background: The initial report compiled by OSU scientists (*A Restoration/Enhancement Plan for the Corvallis Riverfront, September 22, 1999*) acknowledged the need to minimize the risk of damage to infrastructure, specifically the CSO tunnel, during floods. We recognized the city's responsibility to protect public investment in the CSO and the potential need for some degree of bank stabilization. The second report of findings of the Peer Review Group (PRG) appointed by Mayor Berg concluded, among other things, that the location of the Geotechnical Stability Line determined in the original analysis by consultants should be shifted 1-2 feet to the west. The report concluded that space for improvements is not limited by the Geotechnical Stability Line north of Madison Avenue, but such space is limited between Western Avenue and Madison Avenue. This area has come to be known as the "pinch point". In such space-limited areas east of the Geotechnical Stability Line, the PRG identified two types of actions available to decision makers: (1) actions that essentially shift the stability line through active stabilization of the riverbank, or (2) actions that modify the dimensions, locations, or functions of improvements so that they are not placed between the crest of the riverbank and the Geotechnical Stability Line. The PRG report also acknowledged that Type 1 action, or mechanical bank stabilization, would result in additional loss of ecological function of the riverfront riparian forest. It is our understanding that the City Council has decided to adopt the first type of action, and thus mechanically stabilize the riverbank in these areas. This course of action has ecological implications and costs, but allows park amenities to be built with less risk. Among the technological alternatives available to stabilize the riverbank, a combination of shear pile and micropile construction appears to pose the least risk to existing riparian trees and for that reason is the most appropriate alternative for mechanical stabilization of the riverbank.

Anticipated Impacts of Bank Stabilization Measures to Vegetation: Shear piles would be used in zones of stability concern where installation would not require removal of "priority" trees or result in severe damage to their canopies and root systems. Micropiles would be used adjacent to priority trees because they can be installed below the height of the tree canopies and occupy a smaller volume of the upper soil horizon, thereby limiting potential damage to root systems. To our knowledge, there has been no research that documents the effects of this type of stabilization technology on existing vegetation along rivers. Based on discussions with engineers and our knowledge of riparian plant physiology, we have identified the following potential risks to existing trees with the installation of shear piles and micropiles:

1. Construction of either shear piles or micropiles may ultimately require pruning of some branches of nearby trees.
2. Construction may result in accidental damage by heavy equipment to adjacent tree trunks and branches. Open wounds provide access for pathogen infection. In addition, major limb loss or severe damage to main stem vascular tissue could result in a decline in tree vigor, or less likely, mortality.
3. Construction of both shear piles and micropiles may result in damage to, or complete severing of, important tree roots. Although micropiles installed with their stabilizing

caps totally aboveground probably pose a lower risk to tree roots than shear piles, the piles are six inches in diameter and will be only 18 inches apart. Given that the micropiles are to be installed at a uniform spacing, it seems likely that some major roots of priority trees will be damaged. Root damage may also provide access for pathogens or decrease tree vigor.

4. Although using micropiles minimizes damage to existing root systems in the upper soil horizon, the resultant network of aboveground concrete caps would preclude establishment and growth of native riparian plants in the areas occupied by the caps.

Estimation of Potential Tree Loss as a Result of Bank Stabilization. The proposed bank stabilization will directly impact 13 large trees on the top of the bank, and likely impact an additional 10 trees located near the top of bank. Below is a summary of the trees that will be impacted.

Species	Number of Trees	Impact
Black Cottonwood	2 (2 stems)	Direct - tree located on or very near top of bank
Big-leaf Maple	11 (34 stems)	Direct - tree located on or very near top of bank
White Alder	1 (1 stem)	Direct - tree located on or very near top of bank
Big-leaf Maple	10 (25 stems)	Indirect - tree located near the top of bank

Trees along the "pinch point" were rated in three categories based on size and age, with Priority 1 assigned to the largest, oldest trees. The consultants have designed the stabilization approach to minimize damage to the trees tabulated above, particularly the Priority 1 trees. However, it is possible that the bank stabilization activities could damage or kill some trees. In the best scenario, all trees will survive, recovering from branch removal and any root damage within a few years. The worst scenario would be that all trees will be seriously injured during the bank stabilization activities and will eventually die. The most likely outcome is that two or three of the trees that are currently in poor-to-fair condition will die within a few years of construction activities and have to be removed.

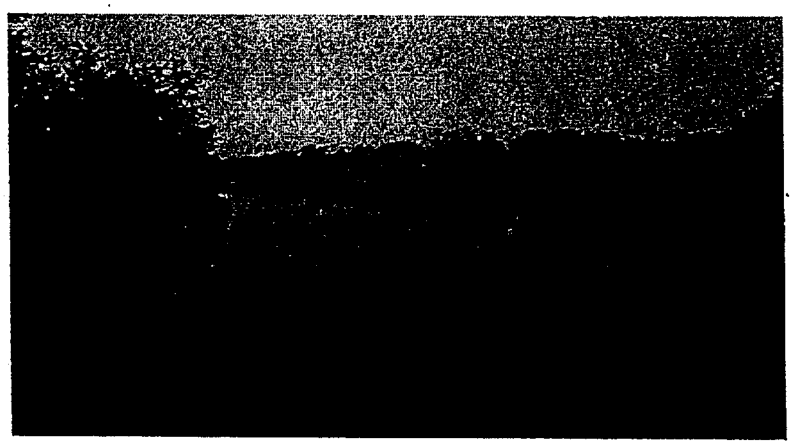

EXHIBIT D

Rebuttal Comments Addressing Geotechnical Slope Stability and Stabilization of the Riverbank Using Pilings

(CH2M Hill)

Rebuttal Comments addressing Geotechnical Slope Stability and Stabilization of the Riverbank using Pilings

TO: Dan Peterson/CVO

COPIES: Vince Rybel/CVO

FROM: CH2M HILL

DATE: August 22, 2000

Stability of the Corvallis Riverfront and the Geotechnical Stability Line

In response to public concerns, an ecological restoration approach was adopted to stabilize the Corvallis Riverfront in lieu of soil bioengineering. Soil bioengineering would have excavated the bank, and replaced it with soil and native vegetation over a layer of geotextile material.

Ecological goals of (i) preserving all existing trees on the riverbank, (ii) replacing invasive plants and debris with native plants, and (iii) reducing risk of erosion and sedimentation to the Willamette River are all accomplished by the Riverfront Commemorative Park and Riverbank Ecological Restoration Plan.

The slide that occurred in 1996 indicated that the Corvallis Riverbank may be prone to slope stability failure. A low margin of safety against slope failure was confirmed by geological and geotechnical engineering evaluations. These evaluations were thoroughly scrutinized by the Peer Review Group, and their findings were published in the Report *"Riverbank Stability Analysis Peer Review for the Corvallis Riverfront Project"* submitted to the Corvallis City Council on January 4, 2000. The Peer Review Group consisted of ten scientists and engineers (including 3 OSU Engineers and 3 OSU Scientists) with diverse backgrounds.

The purpose of having a diverse group was to ensure that other (than geotechnical) potentially relevant factors affecting the stability of the riverbank could be incorporated. These other factors included the effects of plant roots on the stability of the riverbank, historical and future river flow patterns, bank erosion rates, and other.

The purpose of establishing the Geotechnical Stability Line was to establish the setback from the riverbank edge where the risk of bank failure would be minimal. As pointed out by James Robbins, this line is not a physical entity, but it defines a zone where the margin of safety is unacceptably low i.e., where the risk of slope failure is unacceptably high. As stated in the Peer review report: "This zone represent a region of relatively high risk for development. Conceptually bank retreat into this zone could occur in a given event from relatively shallow translational or rotational slides, or from a combination of local erosion and bank failures. Failures in this zone would be infrequent but may occur within the life of the development project. Such events have occurred several times in the 150 years since

Corvallis was established". In the Corvallis Riverfront, this zone of relatively high risk extends west from the existing top of bank for 18 to 20 ft.

Although the location of the Geotechnical Stability Line is dependent on the assumptions adopted in the evaluation, it must be remembered that these assumptions were vigilantly dissected, and the sensitivity of a variety of factors and differing assumptions were tested as part of the Peer Review Process.

The Peer Review Group concluded that *"the methods used to perform geotechnical stability analyses, parameters used in the analyses, and the resulting determination of the Geotechnical Stability Line are technically valid and are consistent with the standard of practice in engineering."*

Riverbank Stabilization

Approaches to deal with the possibility of slope instability in the 18 to 20 feet zone from the top of the riverbank include

- Setting back of structural development and community infrastructure beyond the high risk zone, and
- Active bank stabilization through hardened bank materials and bank strengthening approaches.

The city of Corvallis has adopted a management strategy employing both of these measures – choosing to allow some erosion and failure processes to occur while also employing setbacks, stabilization, and managing bank conditions so that successive failures will not threaten any infrastructure.

Whereas the largest part of the 3,000 ft riverbank will be managed by setting back the park infrastructure and by ecological restoration of the riverbank, a relatively short 700-foot section behind the Post Office and in sections under the Jackson and Madison Avenue will have to be stabilized.

Different methods of stabilization – without removing trees - were considered. These included 1) Soil Nails, 2) Soil screws, 3) Anchors, 4) Shear pilings, and other. The installation of soil nails and soil screws requires construction on the riverbank slope which is very steep and overgrown. This construction would have been detrimental to many trees. In addition, these methods entail the horizontal or near horizontal penetration of the riverbank so that plant roots would have been damaged.

Apart from the option of no construction, the installation of shear piles from the top of bank behind the tree line represents the superior stabilization technique regarding damage to the existing trees. This technique was also economically the most viable.

Two types of shear piles will be used; 1) Large diameter drilled shafts and 2) Micropiles. Large shear piles will consist of cast in situ reinforced concrete shafts that will be about 2.5 ft in diameter and will be installed at 5.5 ft centers to a depth of about 50 ft. To install large diameter piers is more economical than to install micropiles. Micropiles will be 6-inch diameter steel pipes filled with concrete and a reinforced by a single rebar in the middle. These piles will be installed at 2-feet centers.

Micropiles will be used in sections of the riverbank where damage to trees is of concern, i.e., at sections where pilings need to be installed relative close to large trees. Because smaller construction equipment is needed to install micropiles, compared to the relatively tall masts needed for installation of the drilled shafts, the damage to overhanging tree canopies can be minimized. Also, because of the small diameter of the micropiles, the effects on plant roots will be minimized.

Rebuttal Comments responding to Citizen Statements

A number of grossly inaccurate statements were observed upon reviewing some of the comments from James Robbins 8/16/2000. It is nearly impossible to respond to all these issues, but by highlighting some of them, the trend of inaccurate statements can be revealed.

Statement 2(a): "... is based on sediment sample taken from the wastewater treatment plant..."

Fact: This undisturbed sample was taken by Shelby tube from boring B-13-99 at the Corvallis Riverfront. The boring is located at the eastern (river) side of First Street, in the vicinity of the Corner of First Street and Jefferson Street.

Statement 2(b): "... This sample is significantly different from core samples (B1-B4) taken from the riverfront park area (2). Sample from City wastewater plant is a silty clay (CL) while those from the same depth at the riverfront range from silty sand (SM) to silt (ML) according to the Unified Soil Classification System (3)."

Fact: Again, this sample was from Riverfront and NOT City wastewater plant. Validity of using the laboratory test results on this sample has been established by the Peer Review Group. This sample is classified as CL (lean clay), and it plots above but close to the A-line on the Plasticity Chart for fine-grained soils. It is common for Willamette Silt material to plot on or just above or just below the A-line so that samples may be classified as ML, CL, CH, or MH materials. Three samples, B-1 (3-S); B-2 (2-S); and B-5 (2-S) taken from the Riverbank for the CSO project tested as CH materials (CH2M HILL, 1996) and not as a ML material as the statement suggested. Please note that engineering characteristics of a silt (ML) that plots below but close to the A-line will be similar to that of a lean clay (CL) that plots above but close to the A-line.

Statement 3(a): "... more weight was given to attached shear strengths of cohesive of clay sample (c=604 PSF), however, Table B3 references an effectiveness (c') of 300 PSF. This difference suggests that the cohesiveness data is taken from unpublished shear strength analysis from Willamette silts."

Fact: In this statement *total stress* strength parameters and *effective stress* strength parameters are compared, which is the same as comparing apples to oranges. This statement is dead wrong. Effective stress analyses (and not total stress analyses) were used in Peer Review Report. Again, the validity of using appropriate strength parameters for stability analyses has been confirmed by Peer Review Process.

Statement 3(c): "They conclude that Missoula flood sediments are more hardened than Holocene alluvial sediments such as Willamette silts, and thus more resistant to fluvial erosion.

Fact: Willamette Silt is present at Riverbank to a depth of about 25 ft. The composition, characteristics, and consistency of this material is similar to that of Willamette silt elsewhere in the Willamette Valley. The Peer Review Group conceded that material at Riverbank is Willamette silt.

Statement 3(d): "Slope stability study did not consider the contribution of silica cementation and lamination of horizontal rhythmite sediment strata on resistance to circular failure.

Fact: Analyses were based results of triaxial shear tests. These tests are performed on undisturbed samples in a way to reflect the strength increases from lamination, cementation, and sedimentation in the obtained strength parameters.

To conclude: James Robbins suggested that plant roots will mainly stabilize only shallow slides, and therefore that the focus of a stabilizing investigation should have been on shallow slides. He suggested that a bioengineering model be used for these analyses. Conversely, the philosophy adopted to determine the Geotechnical Stability Line was to assume that vegetation will stabilize the bank to a large extent against shallow slides. Also, if shallow slides occur it should have a less detrimental impact than deeper slides. Because the consequences of a deeper slide is more serious and may destroy park infrastructure and pose endangerment to human life, the stability analyses focused on establishing the risk of deep slides occurring.

Riverbank Stability Analysis Peer Review

for the

Corvallis Riverfront Project

Report to the Corvallis City Council

January 3, 2000

Peer Review Group:

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Conclusion 1:
The group concluded that the methods used to perform geotechnical stability analyses, parameters used in the analyses, and the resulting determination of the Geotechnical Stability Line are technically valid and are consistent with the standard of practice in engineering.

The PRG evaluated the scientific and technical basis for the geotechnical stability analysis and for the location of the resulting Geotechnical Stability Line, as well as its conformance with the standard of practice. The group examined the parameters used in the analysis, plausible ranges for critical parameters, and the need for other possible parameters in the analysis. Though additional factors are relevant to the riverbank stability and should be considered by the city in the future, the modified Geotechnical Stability Line serves as a valid and useful framework for making long-term decisions about the Corvallis riverfront.

Conclusion 2:
The analyses incorporated a range of relevant factors, but it is not a true "worst case" or "best case" analysis. It represents a range of plausible estimates.

The Geotechnical Stability Line was determined for current conditions, which include toe-slope erosion protection from the existing riprap. Variation in soil strength, water levels, reinforcement from tree roots, and elevation of the riprap toe-slope protection result in a geotechnical stability "band" rather than a single line. The Stability Line is midrange in the band, but not necessarily exactly in the center of the band due to the relative weight of individual factors in the stability analysis.

Conclusions 3:
The location of the Geotechnical Stability Line (determined in the original analysis) should be shifted 1 ft to 2 ft to the west; closer to the center of the east and west limits of the "band".

The position of the Geotechnical Stability Line varies locally with respect to the top of the riverbank as a function of slope steepness and height. The location of the Stability Line from the bank crest ranges from approximately 10 ft at the downstream north end of the park (lower and less steep banks) to approximately 20 ft at upstream south end of the park (higher and steeper banks).

In contrast, the position of the stability line with respect to the property line on the west side of First Street varies from about 40 feet east of the property line at Jefferson Avenue to about 185 feet east of the property line at the north end of the project. This variation in distance of the Stability Line from buildings along First Street is directly related to the current proximity of the river to the First Street property line and bank steepness and height.

Space between the First Street property line and the Geotechnical Stability Line can be considered to be an area in which selected park elements (e.g., utility lines, sidewalk, street or bike-path, parking, river-front walking path, park structures) could be included without the need for stabilizing measures. This area includes Stability Zone 3 and part of Stability Zone 4 shown schematically in Fig. 2a.

Conclusion 4:
Though the model projections cannot precisely define the location of the Stability Line, the series of cases examined by the group indicate that shifts of only a few feet can involve relatively large changes in the factor of safety.

Conclusion 5:
Space for improvements is not limited by the Geotechnical Stability Line north of Madison Avenue, but space for improvements generally is limited between Western Avenue and Madison Avenue (not based on any specific plan for the Park).

The location of the Geotechnical Stability Line and the methods used to determine its location do not dictate a particular riverfront development plan. An array of options exists for the Corvallis riverfront (e.g., sidewalk, street, bike-path, parking, river-front walking path, streets, plazas, park structures, open-space, riparian forest). However, some of these options may require stabilization measures or changes in park design to meet the current standard of practice in geotechnical engineering. The Peer Review Group has not considered particular stabilization measures and the pros and cons associated with them. Selection of one development plan versus another is a value-based decision that will carry with it various financial, aesthetic, utilitarian, and ecological benefits and costs.

In responding to the city's request, the Peer Review Group assumed that final decisions had not been made and that the City Council will consider a full range of actions for riverbank management and park design based on the information provided by the stability analysis and peer review of the methodology.

In areas limited by available space east of the Geotechnical Stability Line, two major types of action are available to the city. One type of action that addresses limitations created by riverbank stability includes actions that shift the location of line through active stabilization of the riverbank. A different type of action that also addresses limitations created by riverbank stability is modification of the dimensions or locations of improvements so that they are not placed between the crest of the riverbank and the Geotechnical Stability Line.

Stabilization efforts could make the bank more stable and move the Stability Line east toward the bank crest. These actions would allow a higher level of development in areas with limited space than would be possible without stabilization and is more compatible with existing riverfront plans. However, such efforts would incur additional financial costs, monitoring requirements, and losses of ecological function. In addition, the city could incur additional repair costs to park improvements if unanticipated factors cause failures in stabilized reaches.

Alternatively, moving improvements away from the bank crest and to the west of the Stability Line or reducing their dimensions would maintain green space, environmental values, and not require additional construction and expenditures. Small shifts in location of improvments result in significant changes in potential risk. However, potential improvements for the riverfront area would be limited or reduced. This action would require alterations of current development plans. Economic costs and ecological impacts would be reduced.

Each approach can be utilized to varying degrees along the riverfront. Our report should not be represented as favoring either type of action because the group did not study either of them. As a group we are neutral on such actions.

Conclusion 6:
The location of the Geotechnical Stability Line can shift in the future as a result of natural processes or stabilization measures.

The Geotechnical Stability Line is based on current conditions. Stabilization measures for reducing the potential for slope failure will have the effect of moving the Stability Line toward the river. Future natural changes to the riverbank can also move the Stability Line. Local slope failures and erosion of either the existing toe-slope riprap or the riverbank above the existing riprap can have the effect of moving the Stability Line away from the river. Measures taken to prevent or repair future slope failures and bank erosion can maintain the location of the Stability Line. The city will need to have some type of monitoring and repair program to maintain existing conditions. A long-term riverfront management strategy is needed to guide future actions.

Conclusion 7:
Other relevant factors potentially affect the riverbank zone of stability. The Peer Review Group did not have sufficient time to fully analyze these factors or reach conclusions.

Other factors related to riverbank dynamics that were identified and discussed by the group include changes in historical and future river flow patterns, landform changes affecting flood hydraulics, bank erosion rates, prior upstream filling and riprap placement, influences of riverbank vegetation, and City stormwater practices. In the future, the city may want to evaluate or monitor several of these factors.

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INTRODUCTION

Erosion as a natural process

Along much of its length, the Willamette is a meandering river. Erosion and deposition are normal processes that have shaped the Willamette River. Rivers constantly adjust in response to changes in flow, sediment loads, and river boundaries. Erosion and deposition occur irregularly over time (not continually) and generally extend over limited distances of a few feet to several hundred feet along a given bank. Erosion is mainly associated with winter floods, particularly the larger, less common floods, during which bank lines and channels can move. These dynamic processes occur on even the most pristine streams and are natural and necessary for proper ecological function. Erosion and sedimentation become "problems" when they impact human structures and activities.

Rivers and their riparian corridors are modified for a variety of reasons - most commonly to protect investments in property or structural development. Structural developments along streams often increase the likelihood of conflict between ecological processes and social needs to protect property. Many of the adverse consequences of development can be avoided through careful planning or can be mitigated through land-use adjustments. Others require direct intervention using erosion control measures that can have varying environmental consequences.

Corvallis and the Willamette River

Over past centuries, the above processes have formed a wide floodplain for the Willamette River. Corvallis was settled on a high, relatively stable bank at the western edge of this floodplain, where natural changes tend to be much slower (Fig. 1; map or air photo of river and floodplain including upstream and downstream reaches). Maps of the Willamette River from the General Land Office surveys in the 1850s show that the west riverbank in downtown Corvallis has been one of the most persistent and unchanging banks in the mainstem Willamette River over the last 150 years. The degree to which attempts by Corvallis to protect the bank over the last century have reduced erosion is unknown, but the bank clearly has not eroded west of its current position since the last glacial period. But changes associated with meandering are evident both upstream and downstream of Corvallis. For example, meandering eroded the west bank of the river downstream of Corvallis, and meandering eroded the west bank of the river downstream of the Marys River mouth in the 1890s. A major meander loop just upstream was cut off in the early 1900s, and a gravel bar continues to change to this day in the same cut-off zone near the Crystal Lake Drive boat ramp.

Use of the Willamette River for commerce from the late 1800s through the early 1900s required access to the riverbank. Docks and buildings for river commerce disturbed natural banks and led to dumping of fill material, either to compensate for local erosion or to provide better access to vessels. This fill material included poured concrete, chunks of concrete, junked autos, riprap, scrap metal. Much of this material has been buried, grown over by trees, and generally incorporated into the bank. River vessels also needed a stable channel, which Corvallis tried to provide by controlling bank erosion with revetments and by dredging the channel to prevent bar formation. Such activities wound down by the 1970s. Meanwhile, dams and reservoirs were built in the Cascade foothills primarily for flood control during the 1950s and 1960s. The reservoirs reduce flood peaks but still release the same total volume of winter runoff. This leads to smaller peaks but longer periods of intermediate flows. Spring runoff is held back by these reservoirs for summer release, roughly doubling the late-summer flow past Corvallis. This augmented summer flow dilutes the effects of river pollution and improves river recreation.

With the demise of riverboat shipping, the Corvallis riverbank has been left alone for the past few decades and most of the early riverfront buildings have been demolished. A gallery forest of native riparian tree species has become well-established along the riverfront hiding much of the past debris thrown over the side and better protecting the bank from surface erosion. However, recent planning and development activities along First Street have made it necessary to reconsider the riverbank. The local bank slide (160 ft long) in February 1996 alerted people to the importance of specifically including riverbank erosion in planning.

PURPOSE AND PROCESS OF THE PEER REVIEW

In response to recent questions about the stability of the bank of the Willamette River in Corvallis, CH_2M-Hill developed a Geotechnical Stability line (previously referred to as a Factor of Safety line). The Stability Line is a conceptual framework that identifies zones that have a greater potential to exhibit erosion from slope instability in the future and zones in which such events are less likely. This Stability Line provides a design element for protecting community infrastructure against possible erosional effects along the Corvallis riverbank. The Stability Line delineates the boundary where community infrastructure is considered to be adequately protected by an acceptable factor of safety.

Given the importance of the location of the Stability Line for planning roadway and park improvements along the riverbank, the City Council asked the Mayor to appoint a Project Review Group (PRG) comprised of engineers and scientists to review the technical rigor and conceptual framework for the analysis. The PRG charter established by the Council was to:

> Review the methodology for the establishment of the Corvallis riverbank geotechnical stability line.
> Recommend changes to the methodology if appropriate and the resulting change in location of the geotechnical stability line.

The Mayor appointed a group of 10 professionals from relevant engineering and scientific disciplines (Appendix A). The PRG met three times, each meeting lasting about 5 hours. CH_2M-Hill staff for the bank stability project was available to the PRG during all the meetings. Up to a half dozen citizens observed the group's deliberations. Citizen comments about the stability analysis were solicited and received during the first two meetings, and abbreviated comments were received in the final meeting.

During the first two meetings, the PRG evaluated the technical and conceptual basis for the geotechnical stability analysis and the resulting location of the Stability Line. Professional engineers within the group assessed its consistency with the standard of practice in the discipline. The group examined the parameters used in the analysis, plausible ranges for critical parameters, and the need for other possible parameters in the analysis. A final group meeting was held to organize the structure and preparation of this report.

The PRG was selected to provide diverse expertise so that other potentially relevant factors affecting the riverbank zone of stability would be considered. These other factors identified by the group included changes in historical and future river flow patterns, landform changes affecting flood hydraulics, bank erosion rates, prior upstream filling and riprap placement, influences of riverbank vegetation, and City stormwater practices.

Based on the task assigned by the Mayor, the group intentionally excluded several related issues that are being addressed by other groups or decision makers. The group did not analyze alternative riverbank stabilization techniques or future long-term bank management strategies. The PRG also did not evaluate the adequacy of the recently placed riprap to stop future toe erosion. These are the subject of separate ongoing assessments by CH_2M-Hill or joint efforts with OSU faculty and staff. The PRG did not analyze or recommend priorities for alternative park designs.

CONCEPTUAL FRAMEWORK FOR ZONES OF RISK MANAGEMENT

Riverbanks generally fail from 1) hydraulic forces that erode bed or bank material, 2) geotechnical instabilities of native bank material, 3) placement of fill along natural banks, 4) local increases in surface runoff, or 5) a combination of these factors. Bank stability problems rarely result from the operation of a single process of erosion or mechanism of instability. In fact, bank retreat is usually the consequence of many complex interactions among a number of processes and mechanisms that can act simultaneously or sequentially on the bank. The ability to predict exactly when, where, and how these processes may interact is limited.

Approaches for addressing this uncertainty include 1) establishing a zone where dynamic changes in the river are recognized as likely and necessary for the maintenance of river processes and associated aquatic/riparian habitats and 2) active stabilization of the riverbank for local needs. In the first case, where the river is dynamic with frequent changes and high likelihood of failure, structural development and community infrastructure are set back beyond the long-term zone of riverbank erosion, deposition, or instability. In the second case, active bank stabilization is designed to prevent bank retreat through hardened bank materials and bank strengthening approaches. The city of Corvallis has adopted a management strategy employing both of these measures—choosing to allow some erosion and failure processes to occur while also employing setbacks, stabilization, and managing bank conditions so that successive failures will not threaten infrastructure. The setback required for protection of infrastructure on the upper bank can be determined by evaluating the consequences of various erosion and bank failure processes.

Applying this strategy, the group characterized the bank region in terms of zones based on several assumed slope movement and failure mechanisms, their impacts upon the bank and adjacent infrastructure, and their likelihood of occurrence. Four zones were designated along the bank, varying in width depending on local bank conditions. Fig. 2a and 2b show a typical cross section of the bank zones, and each is described below.

Zone 1: This zone encompasses the existing bank and is susceptible to a number of erosion and failure mechanisms including erosion, piping, rilling, and small surface slides and slumps. Bank loss in this zone may be localized and sporadic (i.e., 2-5-yr recurrence). While important and potentially serious over the long term, these failures would not immediately threaten developments on the top bank.

Zone 2: This zone extends from the top of the bank and represents a region of higher risk for development. Bank retreat into this zone could occur in a given event from relatively shallow translational or rotational slides, or from a combination of local erosion and bank failures. Failures in this zone would be infrequent but may occur within the life of the development project. Such events have occurred several times in the 150 years since Corvallis was established. In the Corvallis riverfront, Zone 2 extends west from the existing top of bank for 18-20 ft.

Zone 3: This zone extends westward from the Stability Line Zone to the outer boundary of potential failures. The outer limits of this zone would correspond roughly to a Factor of Safety of 1.5 or higher. Bank loss encroaching into this zone during a single event would be associated with deep rotational (circular) failures. Failures of this type would be rare and there is no evidence of such deep erosion events in the last 150 years. Zone 3 can be regarded as an acceptable zone for unoccupied development such as First Street utility corridor or the riverfront park. It is not considered safe for development of occupied buildings. In the Corvallis riverfront, Zone 3 extends west 10-15 ft beyond Zone 2 (i.e., from about 18 - 20 ft to a distance of about 28 – 35 ft from edge of bank).

Zone 4: Zone 4 can be regarded as the "safe" zone for development. Only very deep rotational (circular) failures would encroach into this zone in a single event, and these would be associated with unanticipated or unforeseen conditions. While risks to structures in this zone still exist, no failures are anticipated. Such events would be caused by processes outside the types discussed by the group (e.g., earthquakes, extreme floods larger than historical records). Such events have not been observed in recent history and are not evident at the site.

The assessment used to characterize the zones is based upon existing conditions. If these conditions change, whether from stabilization measures, erosion processes, or other factors, the position of the zones may shift as well. The time frames for erosion events within these zones are based largely on recorded history over the last 150 years and geologic and vegetative evidence at the site.

METHODOLOGY FOR GEOTECHNICAL STABILITY ANALYSES

A series of geotechnical stability analyses were carried out by CH_2M-Hill as part of the riverbank stabilization project. The purpose of these analyses was to establish the setback from the riverbank edge where the risk of bank failure would be minimal. Analytical procedures used in these analyses were those conventionally used by civil engineers for establishing the safety of slopes.

Definition of the Geotechnical Stability Line and Factor of Safety

Geotechnical stability analyses were used to determine the Geotechnical Stability Line. The Stability Line will be used by the City Council as a decision-making tool for evaluating park alternatives.

We consider the areas to the west of the Stability Line to be relatively safe from future erosional processes and thus suitable for locating the multimodal path, First Street or other important park facilities. On the other hand, there is a greater risk that a bank failure could occur in the area east of the line during the life of the park unless measures are taken to stabilize the bank.

Uncertainties exist in any slope stability analyses; therefore, a margin of safety (defined by a Factor of Safety) was used to define the Stability Line. The margin of safety is used to account for uncertainties in the method of analysis and uncertainties in selecting soil strength, geometry, and water conditions for the analysis. The Factor of Safety can be considered as a comparison of the forces causing the slope to slide (weight of soil, water pressures, etc.) with the forces tending to resist sliding (shear strength of the soil, reinforcement by tree roots, etc.).

Another way of thinking about the Factor of Safety concept is to imagine hoisting a 1,000-lb object with a rope that has a breaking strength of 1,500 lbs. The Factor of Safety in this case would be 1.5 (1,500 divided by 1,000). Determination of the rope strength is relatively simple, but determination of soil strength and the other parameters that influence slope stability is far more complex.

In normal civil engineering practice, a minimum margin of safety of 30 to 50 percent with regard to slope failure is considered appropriate (i.e., a Factor of Safety of 1.3 to 1.5). The larger margin (Factor of Safety = 1.5) applies to cases where greater uncertainty exists in loading or resisting conditions or where life or safety is a significant issue. For example, a building with several hundred occupants would warrant a Factor of Safety of 1.5 or higher, whereas a riverfront park that has occasional use might warrant a lower Factor of Safety. In view of the various issues associated with park development, a minimum margin of safety is necessary to protect the public infrastructure. For this project, a minimum Factor of Safety of 1.35 was used to establish the Stability Line.

Slope Stability Analyses

Loads and resisting forces at several key locations along the riverbank were represented in a computer model of slope stability. The computer model then was used to compare those forces causing slope failure with those resisting failure. Where loads exceeded the resisting forces, a slope failure is predicted. For cases where the resistance is greater than the loads, the slope is predicted to be stable. With this computer model, we evaluated different conditions that could occur along the riverbank, including different geometries, river levels, contributions from tree weights and root strengths, and soil strengths. For each analysis, a unique Factor of Safety was computed.

The Factor of Safety determined with this approach quantifies the mechanical stability under a given set of assumptions. It does not determine the probability that a slide will occur at a given time. The approach used to define the Factor of Safety also does not determine the amount of movement that will occur in the event of failure. Movement could be large, on the order of several tens of feet, or small, on the order of inches. Normally, the amount of movement will depend on those conditions causing instability, such as the steepness of the slope or the change in groundwater condition. While these clearly are limitations, the method reflects the current state of practice in the civil engineering profession.

The following assumptions were made for the analyses:

- Analyses were based on existing bank conditions.
- Geotechnical analysis employed in this study considered the static stability of the existing riverbank geometry. For modeling purposes, we assumed that no further erosion would occur along the toe of the slope because of riprap placement.
- Analyses did not consider effects of future bank stabilization.
- Analyses focused on deeper failure surfaces because these failures will impact park infrastructure and under some circumstances may pose threats to personal safety.
- Only limited consideration was given to slides that are shallower than 10 feet. It was assumed that riparian vegetation plays a significant role in stabilizing the bank against these shallow slides and that shallow failures would not have an immediate impact on the park infrastructure.
- Analyses assumed that stormwater runoff from impervious surfaces will be managed so that it will be routed to the river and will not influence bank stability.

For the Steady State Seepage Case, the water seepage forces in the slope are represented by an unchanging or steady line of saturation. The line of saturation chosen in the analysis corresponds to a groundwater level that represents high water level during the rainy season, and therefore represents a regular event. Because this condition occurs frequently, a relatively high Acceptable Factor of Safety of 1.35 is targeted.

During flood conditions, high water levels will exist inside and outside the riverbank slope. The water level outside the slope exerts a stabilizing pressure, which is lost when the river level drops again. If the water level in the river drops so rapidly that the pore pressures within the slope do not have time to change in equilibrium with the drop in river level, a Rapid Drawdown condition develops. Because the Rapid Drawdown case occurs infrequently, a lower Acceptable Factor of Safety of 1.2 is targeted.

In addition to reviewing the assumptions and computations used to determine the Stability Line, the PRG discussed the following issues during their evaluation of the slope stability issues:

- Historically, surface drainage to the riverbank was not controlled. Surface drainage will be controlled in the near future, and this control has been assumed in the slope analyses.
- The First Street interceptor and outfall system was constructed in 1951. Possible effects since that time were discussed and are summarized in final section of this report (see Additional Perspectives Relevant to Riverbank Stability).
- Historical erosion rates have not been affected by riprap protection, which was installed relatively recently.
- Peak flows have been influenced by dam operation since the 1950s and 1960s, and these effects will continue in the future. Modified peak flows since the 1960s have likely reduced riverbank erosion rates relative to those that occurred prior to dam operation.
- Procedures used to determine the Stability Line considered all of these issues.

Details of the slope stability analyses, including input and output from the analyses, are located in Appendix B.

Sensitivity Analyses

The CH_2M-Hill staff performed sensitivity analyses to demonstrate the dependence of slope stability on various parameters and at the request of the PRG. Sensitivity analyses required several additional stability calculations with variations in the base assumptions to evaluate changes to the location of the Stability Line under different assumptions. The influencing factors that were considered in the sensitivity analyses were:

- Soil strength
- Groundwater and river levels
- Trees and roots
- Presence of riprap

The sensitivity analyses produced a series of estimates of the location of the Factor of Safety of 1.35. The outer extremes calculated in the sensitivity analyses form a "band" around the Stability Line.

The significance of a "band" around the Stability Line should not be overstated. By specifying an acceptable Factor of Safety that is larger than 1.0, we have already implicitly accounted for uncertainties in the analyses. In most engineering applications, it is sufficient to account for these uncertainties by requiring an acceptable Factor of Safety that is larger than 1.0.

Results of Geotechnical Stability Analyses

Results of the stability analyses were used to develop a planar map (Fig. 3) showing the location of the Geotechnical Stability Line. This map indicates that the Stability Line on average is positioned approximately 17 ft from the edge of the riverbank (as defined by a Factor of Safety of 1.35).

Sensitivity analyses indicate that shear strength and groundwater conditions in the slope were the two parameters that most affected slope stability (Table 1). As shear strength decreases, the Stability Line is located farther to the west (i.e., away from the edge of the riverbank). The Stability Line also will move away from the river as the groundwater elevation in the soil increases.

Additional results of the sensitivity analyses include:

- Tree roots will increase stability somewhat (i.e., move the Stability Line to the east), whereas the influence of vehicle traffic is insignificant.

- Riprap along the lower riverbank has little influence on the stability of the riverbank with regard to deep-seated rotational failures. However, the riprap serves to prevent toe erosion and oversteepening of the riverbank slopes, which could lead to future slope failures. In discussions not directly related to the results of model analyses, the group concluded that the newly placed riprap likely will play a significant role in arresting future erosion along the toe of the riverbank.

The PRG used the information in Table 1 to define a band around the Geotechnical Stability Line. The intent of this band was to understand the effects of different, but possible, assumptions regarding soil strength and groundwater conditions that could occur. The outer or extreme projections of the band are approximately 15 ft wide ranging from 13 ft from the edge of the riverbank to 28 ft from the edge of the riverbank.

These results suggest that the Stability Line (determined in the original analysis) should be shifted 1 ft to 2 ft to the west to be more closely centered roughly between the east and west margins of the "band". As an example, the Stability Line would be 18 ft to 20 ft from the edge of the riverbank in the narrow section between Madison and Western Avenues. The Stability Line (in yellow) and the extreme extents of the "band" (in red and green) are illustrated in Fig. 3.

Results of the geotechnical stability analyses at a typical cross-section (Section 12+50) at the narrow section upstream of Madison Avenue are presented in Appendix B. These results show that there is a higher risk of shallower slides than deeper failures. Factors of Safety increase as the assumed failure surface is positioned deeper into the slope.

Implications for actions related to the Stability Line

Stabilization could move the Stability Line east toward the bank crest and allow the placement of park improvements closer to the bank than would be possible without stabilization. Alternatively, moving improvements away from the bank crest and to the west of the Stability Line would increase green space and environmental functions and decrease the need for special stabilization approaches.

The decision regarding "where" to place park improvements is an important one for a variety of reasons. If improvements (e.g., roads, overlooks, plazas) are located between the bank crest and the Stability Line, potentially high design and construction costs could be required to stabilize the bank for the protection of the improvements. Such decisions may be warranted where benefits to the community are high and ecological loss is relatively low. Such stabilization techniques are widely used and would likely eliminate any need for further bank stabilization in the near term. But the City could incur significant restoration costs in such areas if unforeseen factors cause riverbank failures in the future (see final section that discusses other influencing factors). In addition, placing improvements east of the Stability Line and nearer the river comes at an increasing environmental cost (i.e., loss of biodiversity, large trees, green space, aesthetics). These economic and, to a lesser degree, environmental costs could be particularly high in the narrow section where streambanks are relatively high and current plans indicate little setback between the riverbank and the proposed improvements.

Another approach for addressing areas where space is limited would be to locate improvements to the west of the Stability Line to reduce or eliminate the need for specialized stabilization techniques. It could also reduce or eliminate the need for a rapid or costly response by the City should local bank erosion occur during a future storm. Design and construction costs for specialized stabilization approaches would also be corresponding low, but might entail a higher level of monitoring of bank processes with time. In addition, a greater portion of the area along the river crest would be available for "green space". Biological and aesthetic functions associated with green space and riverfront forests would be maintained or improved. This approach would provide less space for improvements and would require modification or elimination of some of the elements of park improvements that have been considered.

The Peer Review Group does not advocate any particular choice but simply identifies the implications of the geotechnical analysis for decisions based on riverbank stability

ADDITIONAL PERSPECTIVES RELEVANT TO RIVERBANK STABILITY

The PRG identified and discussed additional factors that are related to riverbank stability. These issues included changes in historical and future river flow patterns, landform changes affecting flood hydraulics, bank erosion rates, prior upstream filling and riprap placement, influences of riverbank vegetation, and stormwater management. The group did not have sufficient time to fully analyze these topics and did not reach final consensus or conclusions. We provide a brief description of the factors that were discussed for the information of the City Council and management staff of Corvallis if they choose to evaluate or monitor several of these factors in the future.

Historical Evidence of Bank Erosion

Evidence

Maps of Corvallis and the nearby Willamette River date back to surveys in the 1850s (Fig. 4; maps of Corvallis and Willamette in 1895, 1932, 1995). There is no evidence of past erosion of the downtown Corvallis riverbank for large distances to the west (i.e., greater than 100 ft). Larger channel changes have occurred upstream and downstream of Corvallis, and local slumps and surface erosion (i.e., less than 50 ft deep and less than several hundred ft in length) have occurred within the downtown reach.

Comparisons of historical maps show that river meandering has occurred just upstream of Corvallis since the 1850s. The U.S. Army Engineers developed plans in 1886-87 to control meandering and prevent the river from bypassing Corvallis via a route from a horseshoe bend east of Corvallis (at present-day Morse Brothers plant and East Muddy River channel) through overflow channels to Colorado Lake.

A map from 1890 shows severe bank erosion and a steepened bank along the Corvallis riverbank downstream of the Marys River mouth to Jefferson Street. In about 1907, an abrupt change of river course occurred just upstream of Marys River due to floods that cut off the old horseshoe bend. A large point bar at the east bank downstream of that horseshoe bend was altered after the abrupt channel change (avulsion) and had less effect on flow alignments approaching Marys River and Corvallis.

Additional changes in channel and bank features occurred after 1910. In particular, substantial fill at the bank downstream of Marys River is evident in a 1932 aerial photograph by the U.S. Army Corps of Engineers. This fill covered most of the steep eroding bank, pushed the bank line out into the channel, and realigned the flow near the bank. Some of the fill material subsequently eroded, as evidenced by later photographs. Visual inspections show that erosion was "counteracted" at many places along the riverbank by the dumping of miscellaneous material. Such fill would be less stable than native bank material, which are comprised of relatively cohesive Willamette silts. Appearance of the remaining fill on the bank suggests that dumped material was destabilized and eroded from the base by undercutting, and also that slippage may have occurred.

While maps, photographs, and survey records are extremely important sources of evidence about riverbank instability, they must be interpreted with caution. The techniques used to produce such documents vary greatly and are closely related to the objectives for their creation. Supporting information (e.g., dates, position of cameras, water levels, instrumentation) frequently is unavailable. Comparisons based on historical records are probably most valid at coarser scales of resolution and their uncertainty increases as the scale of interpretation decreases.

Rate of Historical Bank Erosion

A widely publicized brochure supporting the November 1998 "riverfront restoration" ballot measure made this statement: "The riverbank is eroding at an average rate of one foot every three years. If the ground isn't stabilized, First Street and its adjacent businesses -- as well as the planned Riverfront Commemorative Park -- could be significantly threatened." This claim raises alarm that a fix is needed. Therefore, the PRG explored evidence related to the historical erosion rate.

The 1997 Bank Stability Report was the basis for rates of historical erosion originally reported in the Corvallis Riverbank Project. The Executive Summary stated "The top of the bank has been retreating at an average rate of 1 foot in 3 years. The retreat has been variable, both in time and location. The retreat has occurred sporadically as annual river flooding erodes the toe of the bank, then recedes quickly, causing slides." The Findings Section of the report described erosion in slightly greater detail. "The greater portion of the riverbank along the downtown section has historically been receding. Based on the analyses of stereo pair photography it was determined that the top of the riverbank has receded approximately 14 feet over the last 40 years. This is an average rate of about 4 inches per year. However, not all of the riverbank has retreated. A section between Harrison and Monroe Boulevards has actually extended into the river, most likely by filling and sidecasting."

Though additional sources of information are available for further exploration of historical rates of bank erosion, natural deposition, and fill material, our group did not have adequate time to analyze the information and develop precise conclusions. The group did not review the 1997 Bank Stability Report, but we did discuss several aspects of the additional information. Recent additional evidence based on bank line positions from a survey in 1951-52 (actual survey date unknown) and 1998-99 suggests rates of erosion that are consistent with the earlier publicized rate of 1 ft/3 yr. The depicted edge-of-water line shifted westward 38 ft at five street-lines on the south end and eastward 35 ft at two street-lines on the north end. The top-of-bank line shifted westward an average distance of 10 ft for all eight street-lines (an average rate of 0.2 ft/yr). But the top-of-bank line retreated 20 ft at Western Avenue and shifted eastward 20 feet at Jackson and Van Buren streets. However, many questions limit the conclusions based on this survey. The 1951-52 survey was not made to study bank erosion; measurement of the river edge-of-water was incidental to sewer work along First Street for which the survey was made. No dates or water levels are available for this survey, and it has not been georeferenced to aerial photographs of the same area at that time period. Several aerial photographs are available, but rigorous spatial analysis of these photographs has not been completed.

The group briefly examined several other sources of historical information, including a series of air photos from 1936 to 1998. The frequently publicized rate of bank erosion appears unrealistically large for the riverbank in the latter half of this century. The total change indicated by the 1951 survey information or the estimates of erosion rates 1 ft/3 yr are larger than might be expected based on the presence of older vegetation on the bank.

Regardless of the rate used, longer-term historical evidence clearly shows that bank erosion occurs along the Corvallis riverbank. Historically, erosion has been sporadic, rather than an "every-winter" process. Overall, the position of the riverbank has not changed greatly (more 50 ft) since 1850. However, erosive events are well documented. Erosion that was evident on the 1890 map was substantial (more than 10 ft) and extensive; by that same standard, erosion that occurred in February 1996 was substantial and localized. Furthermore, the bank shows many local erosion sites, some partly hidden and protected by vegetation.

Flooding and Floodplain Structure

Historical Floods

Willamette River floods have been observed and reported since "pioneer" settlement days. Floods passing Corvallis occur mainly during November to February. The December 1861 flood must have been spectacularly large for the whole Willamette Valley, as nothing since has come close. The regulated December 1964 flood had a peak discharge at the Albany gage that was only 55% of the 1861 peak, yet is the largest flood since unregulated floods in January 1943 and December 1945. The only floods to come close to the 1861 flood in peak discharge are the February 1890 and January 1881 floods, at 86% and 78% of the 1861 peak. In contrast, the flood peak in February 1996 was only 67% of that in 1964 and 37% of the 1861 flood peak. Considering all floods recorded at Albany, the February 1996 flood ranks 33rd in size, has a return period of 3.5 years, and has a 29% probability of being exceeded in any given year. However, considering only the past 30 years of full flood regulation, the February 1996 flood ranks first in size, has a return period of 31 years, and has a 3% probability of being exceeded in any given year. Thus, floods of intermediate size may cause substantial bank erosion along the Corvallis riverbank.

Floods in the Marys River usually peak earlier than Willamette floods at the confluence. The Marys River basin is about 5% the size of the Willamette River basin at Corvallis. Commonly, peak discharges from storms collect and leave the mouth of the Marys before the full impact of Willamette runoff has reached Corvallis. For example, the December 1964 flood peak occurred on December 22nd for the Marys River, December 23 for the Calapooia at Albany, and December 24th for the Willamette near Corvallis and Albany. One consequence is the interaction of flows from the two rivers and a backwater effect from the high Willamette River that extends up the lower Marys River for a few miles, diminishing its velocities and maintaining water levels in the lower reaches of the Marys River even though discharge from farther upstream is decreasing. This delays outflow of part of the Marys flood discharge and could lead to delayed bank erosion.

Flood Control

Nine federal reservoirs control floods upstream of Corvallis on Willamette River tributaries. The first, Fern Ridge Reservoir, was completed in 1941. The three largest, Lookout Point, Hills Creek, and Cougar reservoirs, were completed during 1953-1963. The last, Blue River reservoir, was completed in 1968. Collectively, the reservoirs control flood runoff from 2,090 square miles of the basin above Corvallis, compared to the total drainage basin size at Corvallis of 4,395 square miles. Thus, runoff control is provided from 43 % of the upstream drainage basin.

Operation of these flood control reservoirs is based on storing incoming streamflow during periods of heavy runoff to reduce downstream river levels and flooding. Because the flood season covers all winter months, reservoir space must be evacuated after a flood to make room for inflow from a possible next flood. This requires releases of large amounts of water for several days after the peak has passed. These flows are maintained at or near bankfull flow in the downstream river channels. Compared to pre-regulation years, the Willamette River now remains at relatively higher flows for more days after heavy rains have stopped and local creeks have returned to lower levels.

Influence of Floodplain Highways East of Corvallis

The group considered potential "damming" effects of highways on the floodplain east of Corvallis. Following the December 1964 flood and again a few years later, low portions of highway 34 just east of the Willamette River were raised a few feet and new culverts were added to pass the blocked water. Water levels at these culverts are routinely higher on the upstream (south) side during significant winter runoff. The differential elevations suggest that Highway 34 creates a backwater effect across the floodplain. This would lead to an increase in the relative amount of flow in the main channel rather than across the floodplain to the east of Corvallis. Similarly, the new bypass highway is constructed on an elevated roadbed above the general floodplain level. To a lesser extent, this new barrier in the floodplain may also increase the relative flow in the river channel versus that across the eastern floodplain. No analysis was made of the degree to which floodplain damming and backwater effects might have increased flow velocities and shear stresses along the Corvallis riverbank. We cannot attribute erosion in the 1996 flood specifically to this effect (several group members felt that it was minor), but the group agreed that it represents an additional factor that is potentially related to risk of future bank erosion.

Bypass Bridge

The group also considered local effects of the bypass bridge footings on flows past Corvallis. The Willamette River span is supported by two large piers in mid channel (each about one-third of the distance across the river), a pier near the east bank, and twin piers near the west bank. The main piers are about 100 feet from the banks--farther away as river levels rise at the sloping banks. These piers are in the strongest part of the river current and interact with the flow. They cause local disturbances, velocity concentrations, and eddies. These dissipate and mingle with the strong river currents within a short distance downstream (e.g., 20-100 feet, depending on flow rate) and produce long narrow wake zones with smoother surface appearance that extend downstream from each pier about one river width (approximately 300 feet). When debris snags against the piers, wakes are wider. Normally, the wake effect does not extend near either bank of the river. The severe erosion zone shown in the 1890 map extends past the bypass bridge for a few hundred feet. The site of the 1996 slide is about two river widths downstream of the bridge, separated by a steep vegetated bank that may be a remnant of the 1890 erosion zone and that was not notably disturbed during the February 1996 flood. The group found no clear evidence that the 1996 bank failure was related to the bridge structure.

Surface Water Drainage on Upper Bank

Large amounts of impervious surface are common in the Corvallis downtown area. Most runoff from these surfaces is normally directed into storm drains. However, along the Corvallis riverfront there are many locations where runoff from impervious surfaces such as bike paths, streets, parking lots, and buildings, is not captured and is not directed into a storm drain system. Such "uncontrolled" surface runoff usually follows low points in the topography and may end up in drainageways with little impact. In other instances, uncontrolled runoff may either create local surface erosion or infiltrate riverbank soils and contribute to their instability by increased bank saturation. Thus, uncontrolled surface drainage that has the capability of providing large amounts of water during rainfall events to the portions of the riverbank may have been a major factor affecting the stability of those banks. Future management of the Corvallis riverbank should avoid routing additional surface water drainage onto the top of the riverbank and thus reduce the potential for bank failure.

Influence of Fill Material on Riverbank

Decades ago, and over a period of many years, fill material was dumped along much of the Corvallis riverfront. Evidence of this historical activity is readily visible along the existing riverbanks (e.g., broken concrete and asphalt slabs, metal objects of various types, sediment particle sizes that are not representative of riverbank soils). In some places, riverfront property owners may have been trying to arrest the erosion at the toe of the slope after floods or fill in and recover ground lost to landslides. The placement of fill might have been a crude attempt to riprap the bank. In other places, the river may have just served as a downtown urban landfill, a convenient place to dispose of demolition debris.

Much of this material appears to have been simply dumped from the upper portion of the bank and allowed to spill down into the river. Thus, the original riverbank slope following a dumping operation would have been relatively steep (essentially at the angle of repose). During periods of low flow, the dumped material remained in place and slowly became revegetated. However, during high flows some of the material at the base of the fill (particularly associated with non-cohesive sediments) could be eroded by the river. This toe erosion would most likely occur during high stages of the river and would ultimately lead to locally over-steepened banks near the base of the fill. Over time, such conditions could contribute to increased likelihood of localized fill failure from an upper bank.

The extent to which the filling contributed to the overall stability or instability of this section of river is unknown. Certainly, the filling makes it very difficult to analyze historic erosion rates. Borings drilled for the new First Street CSO microtunnel did not encounter significant fill. Exploratory test pits excavated between the bike path and top of the slope encountered varying amounts of fill. Test excavations on the slope or near the toe have not been done because of cost, difficulty of the work, and likely damage to existing trees.

Effect of CSO and Pipes West of the Riverfront Area

The PRG raised the possibility that pipelines, i.e. sewer and stormwater pipes, extending westerly from the riverfront area might be channeling groundwater to the riverfront area. When constructed, utility pipes are commonly bedded and surrounded by coarse gravels. The gravels are more porous than the surrounding native ground. As a result, the coarse gravel surrounding the pipes can channel groundwater along the length of the pipeline, acting as what are commonly referred to as French drains. This phenomenon has been documented in other cities. If occurring in downtown Corvallis, it could result in a higher quantity of groundwater and possibly higher groundwater elevations than otherwise might be expected along the riverfront area. Both circumstances, if occurring, could add to bank instability.

As a result of this concern the most recent groundwater readings from groundwater monitoring wells (piezometers) along First Street were reviewed. The wells were installed in the Linn gravels two years ago for the CSO interceptor design/construction. The readings revealed that the groundwater levels fluctuate in a consistent pattern with changes in river levels, rising and falling as the river level fluctuates. From December 1998 to November 1999, groundwater levels averaged 2 ft higher than river levels (ranging from 0 ft to 6.6 ft above river level). The 1952 First Street pipeline, diversion structures/manholes, and new CSO interceptor all penetrate into the Linn gravels. The readings show no evidence of major increases (> 5 ft) in groundwater levels in the pipe zones due to utility French drain effects. In addition, visual observations of current CSO diversion structure excavations reveal no evidence of French drain effects. Excavations for diversion structures (i.e., Western Ave.) have exposed the 1952 First Street pipelines as well as other pipelines coming in from the west. As noted above these pipes are bedded in Linn gravels. During heavy rains in November 1999, there was no excessive groundwater draining into the excavation from the exposed pipe zones coming in from the west. If French drain effects are occurring, existing outfalls to the river (which will be retained) would serve as drainage outlets.

Possible Causes of 1996 Slide

The Peer Review Group discussed the possible causes of the February 1996 slide. Although no definite conclusion was reached, four contributing factors were identified and a failure "scenario" was described:

- Erosion caused by flow velocities and shear stresses, scouring the base (toe) of the riverbank and undercutting it locally or generally along the erosion site.
- Surface water drainage on top of the bank (e.g., from roofs, paved areas, and grassy areas) that entered and saturated the bank, and that either directly caused surface erosion or lubricated potential failure planes and resulted in slippage or both.
- Slightly increased flows in the main river channel at Corvallis due to damming effects of highways on the floodplain east of Corvallis.
- Somewhat increased velocity near the Corvallis bank due to deflection caused by the western main bypass bridge pier.

The most plausible explanation for the February 1996 slide is that toe erosion and surface drainage triggered the slide. There are indications that the slide occurred while local rainfall runoff was appreciable and while the river level was still rising, with increasing velocities and shear stresses, but before the river was near the flood crest level.

Table 1. Results of sensitivity analyses under steady state seepage conditions and rapid drawdown conditions.

STEADY STATE SEEPAGE CASE

CASE	CHANGE IN STABILITY LINE (ft)
BASE CASE	Stability Line @ 17' based on F.S. = 1.35
SOIL STRENGTH	
low strength	7 ft WEST
high strength	4 ft EAST
GROUNDWATER	
high water	7 ft WEST
RIPRAP	
with riprap to el. = 203.5 ft	2 ft EAST
TRAFFIC	0
TREE ROOTS w/o TREE WEIGHT	2 ft EAST
with TREE WEIGHT	2 ft EAST (i.e., tree weight insignificant)
COINCIDENT WORST CASE	
- Low soil strength and high groundwater	11 ft WEST

RAPID DRAWDOWN CASE

CASE	CHANGE IN STABILITY LINE (ft)
BASE CASE	Stability Line @ 17' based on F.S. = 1.2
SOIL STRENGTH	
low strength	6 ft WEST
high strength	4 ft EAST
WATER DRAWDOWN	
large drawdown	6 ft WEST
small drawdown	4 ft EAST

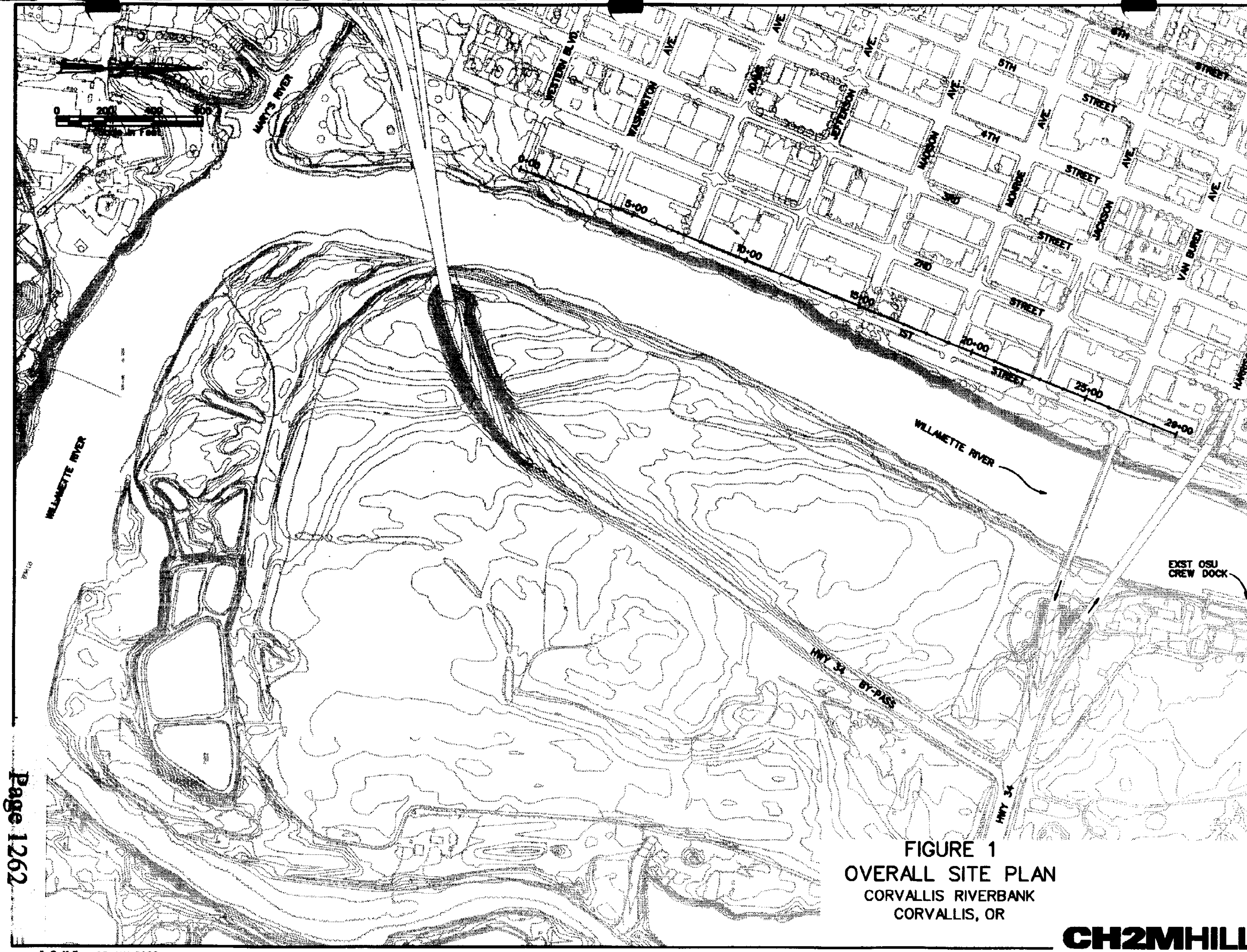
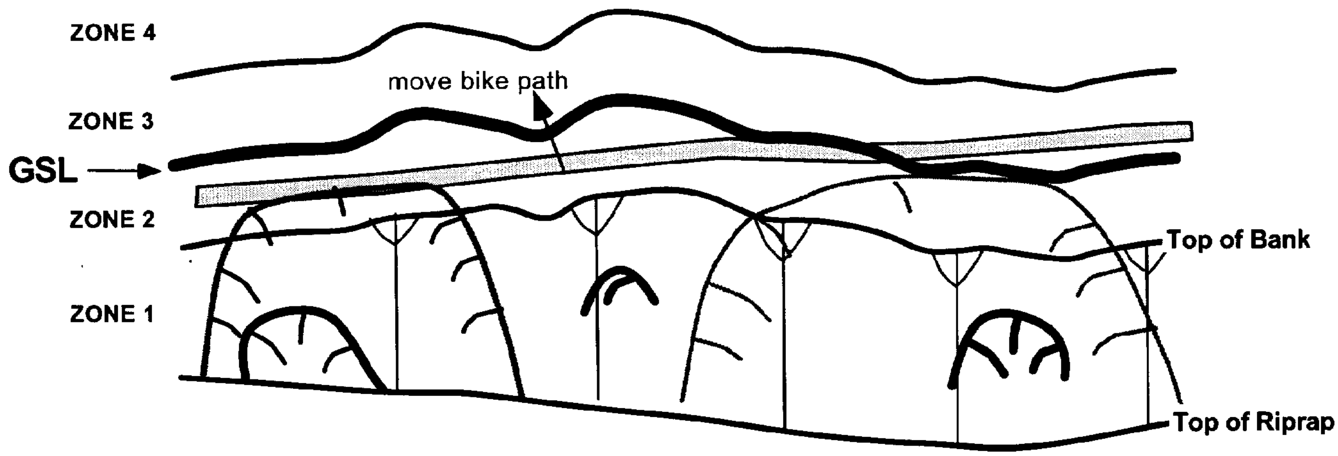


FIGURE 1
OVERALL SITE PLAN
CORVALLIS RIVERBANK
CORVALLIS, OR

CH2MHILL

overall_8x11.fig 03-JAN-2000



ZONE	SIZE AND TYPE OF FAILURE	FREQUENCY OF FAILURE
1	Small surficial slides and slumps	Frequent (1-5 yrs recurrence)
2	Relatively shallow translational or rotational slope failures	Occasionaly, Infrequent (30 yr +/- recurrence)
3	Deep rotational (circular) failure	Rarely, Improbable (100 yr +/- recurrence)
4	Very deep rotational (circular) failure	No Failures Anticipated (>1000 yr recurrence)

Notes:

1. Time frames are conceptual and not quantitatively determined.
2. Impossible to relate to exact probability - no predictive capability

FIGURE 2a
RISK MANAGEMENT ZONES
CORVALLIS RIVERBANK

CH2MHILL

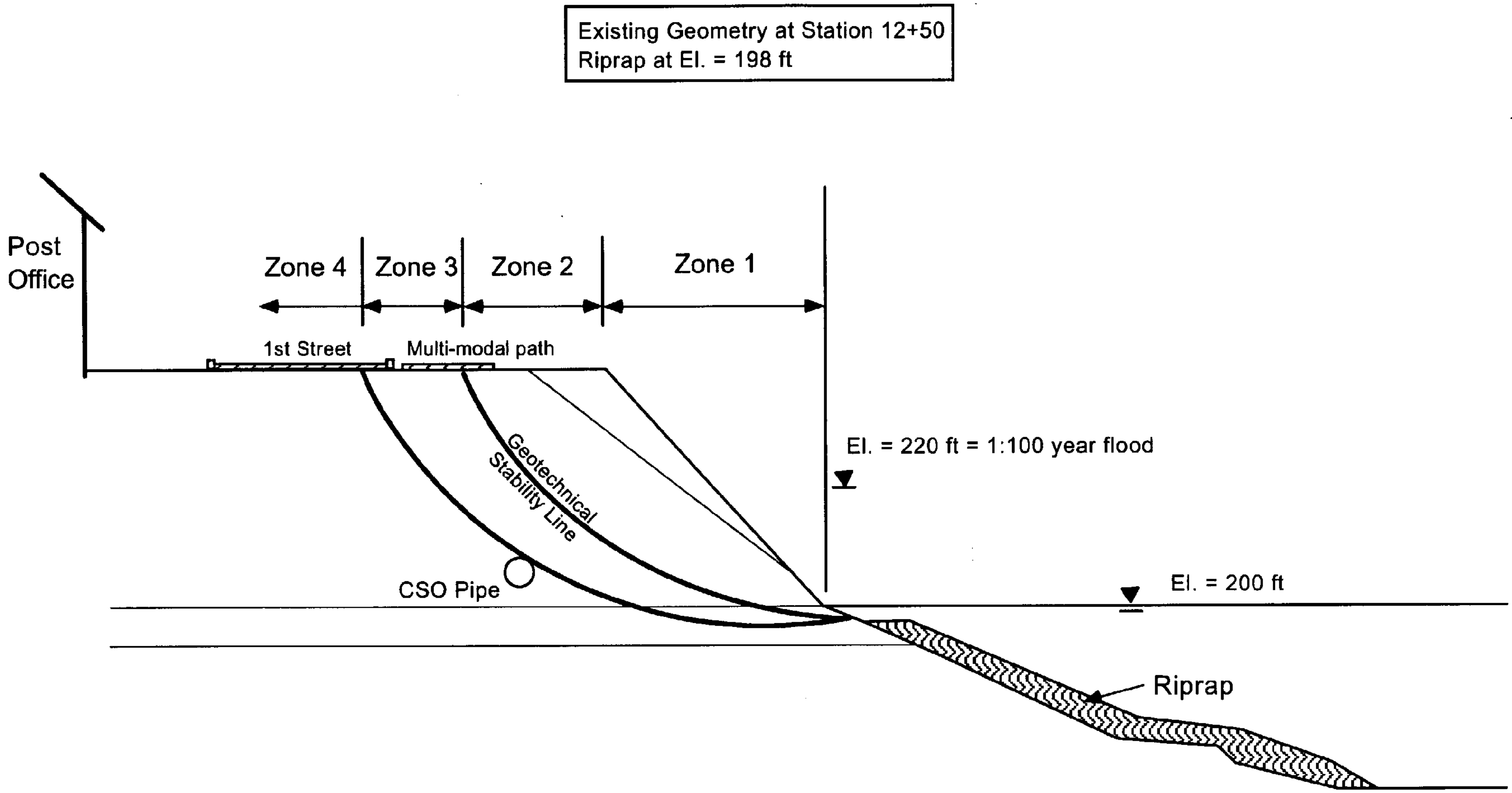


FIGURE 2b
CROSS-SECTION SHOWING
RISK MANAGEMENT ZONE
CORVALLIS RIVERBANK

CH2MHILL

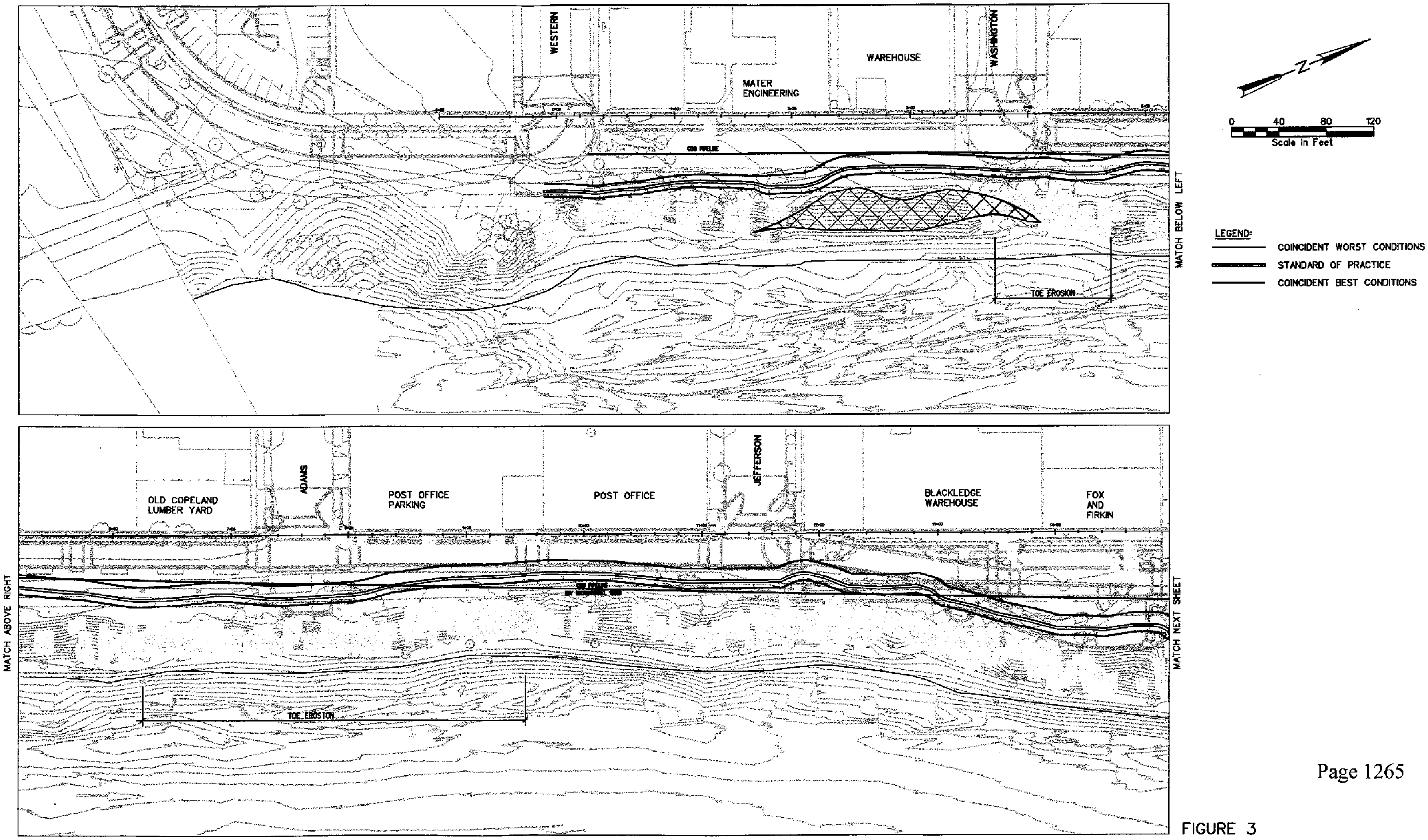


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FIGURE 3
GEOTECHNICAL STABILITY LINE
CORVALLIS RIVERBANK
DECEMBER, 1999

bank-conditions01.dgn 30-DEC-1999 17:13:36

CH2MHILL

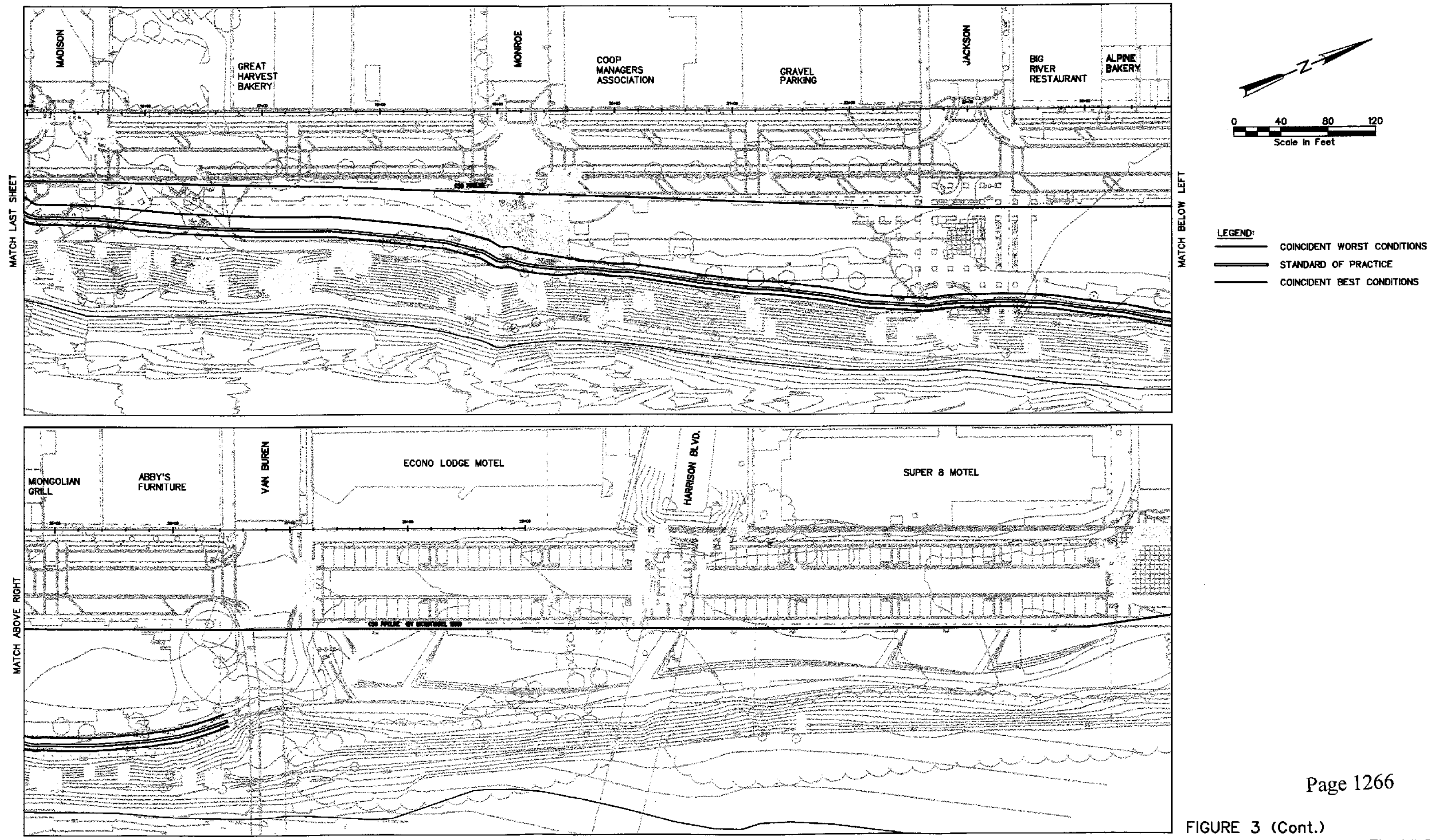

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FIGURE 3 (Cont.)
GEOTECHNICAL STABILITY LINE
CORVALLIS RIVERBANK
DECEMBER, 1999

CH2MHILL

bank-conditions02.dgn 30-DEC-1999 17:05:43

1895

1932

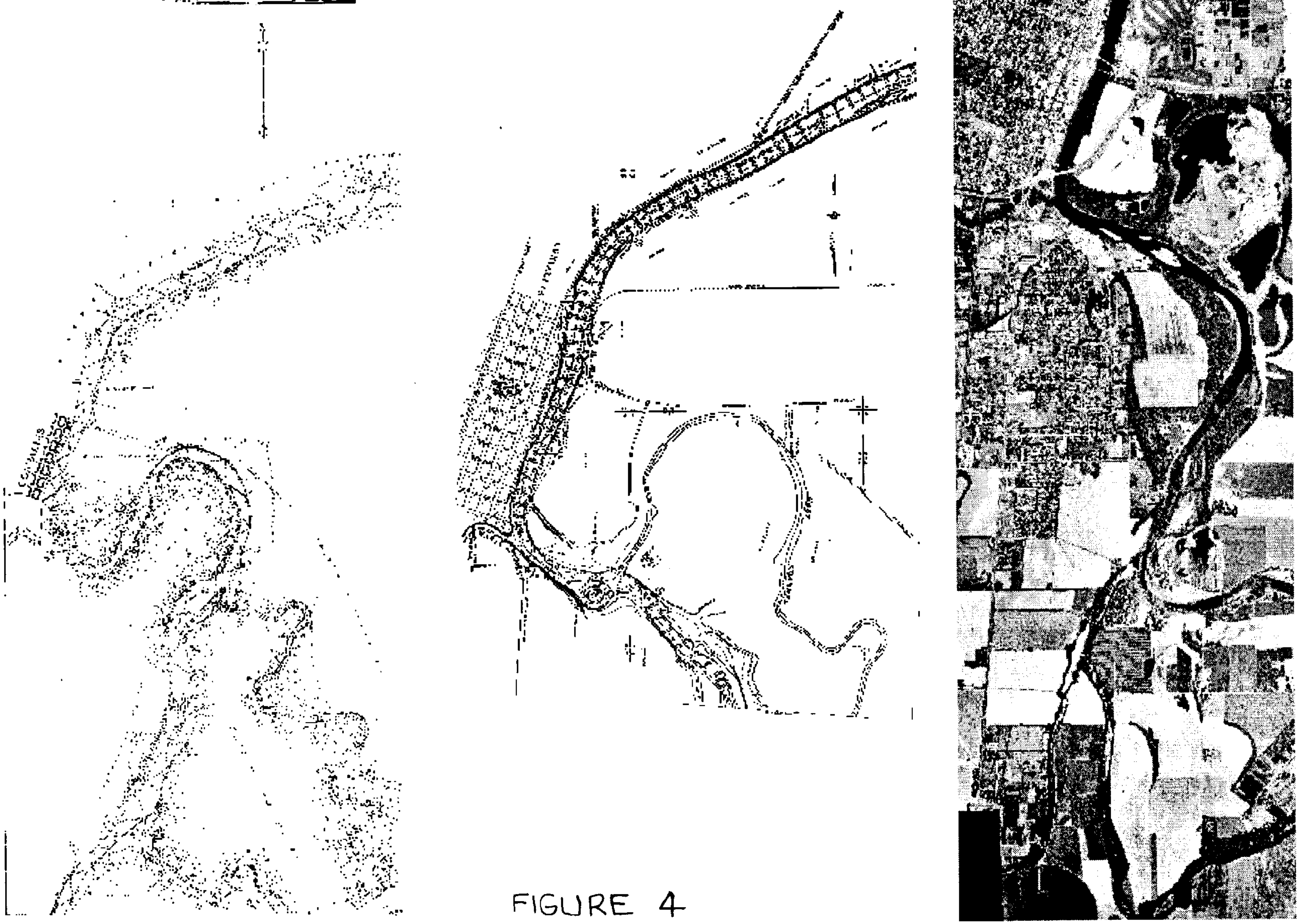

FIGURE 4

Appendix A

Peer Review Group Members:

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Bob Beschta, Oregon State University, Hydrologist
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Appendix B

Description of Geotechnical Analyses in Detail

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Description of Geotechnical Analyses in Detail

Slope Stability Analyses Using Limit Equilibrium Methods

The Geotechnical Stability Line (GSL) can be described as a locus of points showing the locations where the circular failure surface corresponding to the acceptable Factor of Safety daylights along the horizontal ground surface behind the slope crest. Along a given cross-section of the slope such an intersection point was determined by obtaining values of Factor of Safety for three circles (a shallow, intermediate and deep failure surface) and interpolating between these circles to obtain the failure surface corresponding to the acceptable Factor of Safety. The shapes and sizes of these failure surfaces were chosen to reflect the premise that failure would not extend into the dense Linn gravel layer underlying the Willamette silt. Five different cross-sections were analyzed along the riverbank to determine the GSL.

The standard practice of analyzing the geotechnical (mechanical) stability of slopes is by methods of limit equilibrium. In limit equilibrium techniques, slope stability is analyzed by computing a Factor of Safety. The Factor of Safety can be considered as an overall measure of the amount by which the shear strength of the soil exceeds the actual shear stress along a potential failure surface *(F = Shear Strength/Shear Stress required for Equilibrium)*. To define the factor of safety in terms of soil strength is appropriate because soil strength is usually the parameter that is most difficult to evaluate, and involves the most uncertainty.

To calculate a Factor of Safety as defined above, a potential slip surface must be described. Sliding in a cohesive material usually occurs along a curved surface. In stability computations, the real sliding surface is commonly replaced by an arc of a circle, hence the term *circular failure*. When analyzing a shallow failure surface using the limit equilibrium method, the failure surface may be depicted either by an arc of a circle with a large radius or by a plane (translational slide). The term planar failure (translational sliding) is typically associated with sliding on a discrete surface such as a rock joint or along a zone of weakness such as a soft clay layer.

The most common method of performing limit equilibrium analyses is by using *the Method of Slices*. A description of this method can be found in most geotechnical handbooks. In this procedure, the soil above the surface of sliding is divided into a number of vertical sections or slices as shown in Figure B1(a). The stability of each of the slices is calculated separately. The forces acting on a typical slice are shown in Figure B1(b).

The UTEXAS3 computer program was used in this study to perform limit equilibrium analyses. Spencer's procedure was used that satisfies all conditions of equilibrium (moment, vertical force and horizontal force equilibrium). In this procedure, inclination (α) of the resultant forces between the vertical slices is assumed to be the same for all slices and is calculated along with the Factor of Safety as part of the iterative solution.

A typical section (Section 12+50) of the riverbank at the pinch point is shown on Figure B2. The figure shows the different embankment zones used in the stability evaluations.

Stability analyses were based on soil shear strengths of Willamette silt that were historically measured on a number of projects. More weight was given to shear strengths that were obtained from Consolidated Undrained (CU) triaxial tests that were performed recently (1999) on soil samples that were taken from the Riverbank. These test results are attached. The shear strengths used in the analyses are within the range of typical values used for Willamette silt in standard engineering practice.

An acceptable target for the Factor of Safety usually depends on the consequences of failure and the inherent uncertainties associated with the analysis. In normal civil engineering practice, a minimum margin of safety of 30 to 50 percent against slope failure is considered appropriate (i.e., a Factor of Safety of 1.3 to 1.5). The larger margin (Factor of Safety = 1.5) applies to cases where greater uncertainty exists in loading or resisting conditions or where life safety is a significant issue. For example, a building with several hundred occupants would typically warrant a Factor of Safety of 1.5 or higher, whereas a riverfront park that has occasional use might warrant a lower Factor of Safety. In view of the life safety issues of even a park, a minimum margin of safety is necessary to protect the public. A minimum Factor of Safety of 1.35 was used to establish the GSL. For the Rapid Drawdown Case, a minimum Factor of Safety of 1.2 was targeted, given the rare occurrence of such an event.

Steady State Seepage

Steady State Seepage analyses are effective stress analyses in which the shear strength of the soil is related to the effective normal stress on the potential failure surface. The effective stress (σ') is equal to the total stress (σ) minus the water pressure (u) in the pores (voids) in the soil. The pore pressures within the soil must be known and is typically assumed to be hydrostatic (i.e.,$u = \gamma_w h_w$).

Effective stress (drained) shear strength parameters for the Steady State Seepage case are given in Table B1. The phreatic surface in the slope was assumed to be at an elevation of 200 ft.

The three selected circular failure surfaces and their corresponding Factors of Safety calculated from the analyses are shown on Figure B3. The failure surface corresponding to a FS=1.35 was obtained from interpolation between the given circles and is indicated on Figure B3.

Rapid Drawdown

During flood conditions, high water levels will exist inside and outside the riverbank slope. The water level outside the slope exerts a stabilizing pressure on the slope. The stabilizing pressure is lost when the river level drops again. If the water drops so rapidly that the pore pressures within the slope do not have time to change in equilibrium with the drop in external water level, the risk of slope failure will increase significantly. This loading condition is called the Rapid Drawdown Case.

High permeability materials (such as sands and gravels) can drain during rapid drawdown, but low permeability materials (clays and silts) cannot. Because it is difficult to evaluate the pore pressures (and thus the effective stresses) within low permeability soils during drawdown, it is common engineering practice to evaluate the stability of the slopes in terms of total (undrained) stresses. By using undrained strengths the tendency of the material to dilate or compress is implicitly taken into account in the analyses.

Two-stage analysis procedures advocated by Duncan et al. (1990), Lowe and Karafiath (1960) and adopted by the UTEXAS3 program were used for the drawdown analysis. The procedures are based on the general principle that undrained strength is a function of the effective stress state of the soil prior to shearing.

Two stage analysis is performed in three steps:

- 1st – stage: Stability analysis before drawdown is performed using the effective stress parameters for all the materials. This is to determine the effective normal stress on the base of each slice and the effective principal stress ratio, $K_c=\sigma'_{1c}/\sigma'_{3c}$.
- 2nd –stage: Stability analysis after drawdown is then performed by using the undrained strengths for the materials that will not drain during drawdown. The undrained strength is a function of the effective normal stresses acting on the failure surface (base of each slice) and the effective principal stress ratio (K_c). Drained strengths are used for free-draining materials.

Two shear strength envelopes are used to define the shear strengths for the second stage computations (See Figure B4). Both envelopes describe the relationship between the shear strength on the failure plane (τ_{ff}) and the effective normal stress on the failure plane at consolidation (σ'_{fc}). The first envelope is the conventional effective stress strength envelope ($K_c = K_f$). The second derived envelope represents undrained strengths for K_c =1. The shear strength used in the second stage computations is calculated by linear interpolation between the two shear strengths, τ_{ff-R} and τ_{ff-S}.

The parameters that describe the two-stage linear strength envelopes are given in Table B2. It was assumed that the river level is drawn down from a level of 210 ft to a level of 195 ft. This corresponds approximately to the drawdown in river levels that was experienced during the period 1 February 1997 to 17 February 1997 (see attached river stage data for the '64, '95, and '96 winter seasons).

The three selected circular failure surfaces and their corresponding Factors of Safety calculated from the analyses are shown on Figure B5. The failure surface corresponding to a FS=1.2 was obtained from interpolation between the given circles and is indicated on Figure B5.

Sensitivity Analyses

To demonstrate the dependence of slope stability on various influencing factors, sensitivity analyses were performed. Sensitivity analyses involve rerunning of stability calculations with variations in the base assumptions to see what changes occur to the position of the GSL. The influencing factors that were considered in the sensitivity analyses and the upper and lower bounds of these parameters are detailed in Table B3.

Results of the sensitivity analyses are given in Tables B4 and B5. Table B4 gives the calculated Factors of Safety for the three selected circular failure surfaces and Table B5 indicates how the GSL changed location as the different input parameters were altered.

The "best case" – worst case" extremes in the GSL form a band that is calculated to be 15 ft wide ranging from 13 ft from the edge of the river bank to 28 ft from the edge of the river bank. These results suggest that the GSL (obtained for the base case) should be shifted 1 ft to

2 ft to the west to be centered between the east and west margins of the "band", i.e., to a location of 18 ft to 20 ft from the edge of the river bank at the pinch point.

References

Duncan, J.M., Wright, S.G., and Wong, K.S. (1990). "Slope Stability During Rapid Drawdown," *Proceedings, H. Bolton Seed Memorial Symposium*, University of California, Berkeley.

Lowe, J. III and Karafiath, L. (1960a). "Stability of Earth Dams Upon Drawdown," *Proceedings, 1st Pan Am Conference on Soil Mech. And Found. Eng. Mexico City*, Vol 2 pp 537-552.

Table B1. Parameters used for Steady State Seepage Analyses

Zone	In situ Unit Weight (pcf)	c' or c (psf)	ϕ' or ϕ (degrees)
1 (Willamette Silt)	115	200	33
2 (Sand-Linn Formation)	120	0	35
3 (Gravel-Linn Formation)	120	0	40
4 (Riprap)	130	0	50

Table B2. Parameters used for Rapid Drawdown Analyses

First stage strength parameters (same as used in steady seepage analyses)

Zone	Unit Weight (pcf)	c' or c (psf)	ϕ' or ϕ (degrees)
1 (Willamette Silt)	115	200	33
2 (Sand-Linn Formation)	120	0	35
3 (Gravel-Linn Formation)	120	0	40
4 (Riprap)	130	0	50

Second stage strength parameters

Zone	Unit Weight (pcf)	R - envelope		S - envelope	
		d_R (psf)	ψ_R (degrees)	c' (psf)	ϕ' (degrees)
1 (Willamette Silt)	120	700	22	200	33
2 (Sand-Linn Formation)	120	Because it is free-draining use same parameters than for first stage			
3 (Gravel-Linn Formation)	120				
4 (Riprap)	120				

Table B3 Influencing parameters used in the sensitivity analyses

STEADY STATE SEEPAGE CASE		
Influencing Parameter	**Changes from Base Case**	
Shear Strength (Willamette Silt)	High Strengths: c'=300 psf, ϕ = 33°	Low Strengths c'=0 psf, ϕ = 33°
Phreatic Surface	High Water Shore = 210', River = 205'	Low Water Shore = 200', River = 200'
Riprap	Increase top of riprap to El. = 203.5 ft	
Traffic	Equivalent distributed pressure = 300 psf on road area	
Tree roots	Equivalent strength (cohesion) increase of 200 psf	
RAPID DRAWDOWN CASE		
Influencing Parameter	Changes from Base Case	
Shear Strength	High Strengths: c' = 300 psf, ϕ' = 33° d_R = 800 psf, ψ_R = 22°	Low Strengths c' = 0 psf, ϕ' = 33° d_R = 600 psf, ψ_R = 22°
Water Drawdown	Large Drawdown Shore = 215', River = 195'	Small Drawdown Shore = 205', River = 195'

Table B4 Results of Sensitivity Studies

STEADY STATE SEEPAGE CASE

CASE	**FACTOR OF SAFETY**		
	Circle 1	**Circle 2**	**Circle 3**
BASE CASE	1.25	1.45	1.8
SOIL STRENGTH			
low strength	1.05	1.25	1.65
high strength	1.35	1.6	1.9
GROUND WATER			
high water	1.15	1.3	1.65
RIPRAP			
with riprap to el. = 203.5 ft	1.3	1.5	1.85
TRAFFIC	1.25	1.45	1.8
TREE ROOTS w/o TREE WEIGHT	1.3	1.5	1.85
with TREE WEIGHT	1.3	1.5	1.85
COINCIDENT BEST CASE - High soil strength and low ground water	1.45	1.70	1.95
COINCIDENT WORST CASE - Low soil strength and high ground water	0.9	1.1	1.5

RAPID DRAWDOWN CASE

CASE	**FACTOR OF SAFETY**		
	Circle 1	**Circle 2**	**Circle 3**
BASE CASE	1.15	1.35	1.75
SOIL STRENGTH			
low strength	1.0	1.2	1.6
high strength	1.25	1.45	1.85
WATER DRAWDOWN			
large drawdown	1.05	1.2	1.65
small drawdown	1.2	1.4	1.8

Table B5 Change in GSL

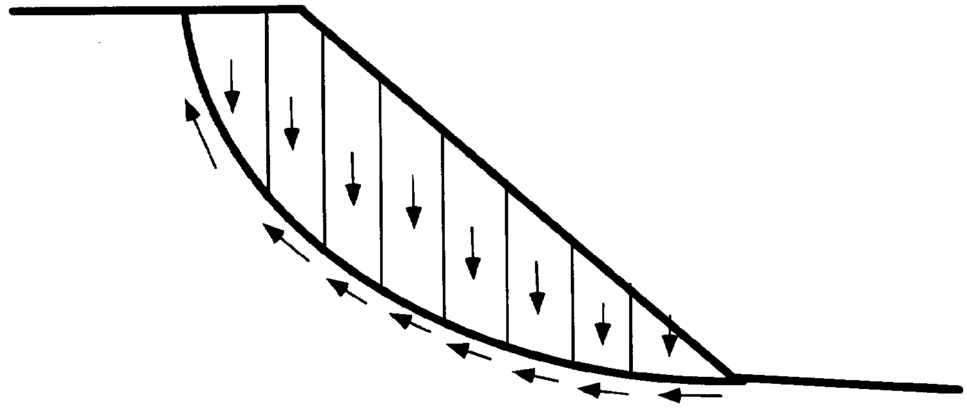
STEADY STATE SEEPAGE CASE

CASE	CHANGE IN GSL (ft)
BASE CASE	GSL @ 17' based on F.S. = 1.35
SOIL STRENGTH low strength high strength	 7 ft WEST 4 ft EAST
GROUND WATER high water	 7 ft WEST
RIPRAP with riprap to el. = 203.5 ft	 2 ft EAST
TRAFFIC	0
TREE ROOTS w/o TREE WEIGHT	2 ft EAST
with TREE WEIGHT	2 ft EAST (i.e., tree weight insignificant)
COINCIDENT WORST CASE - Low soil strength and high ground water	 11 ft WEST

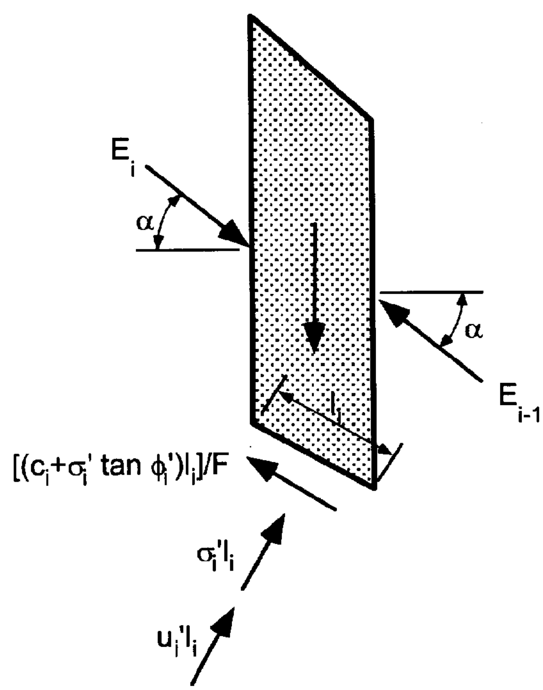
RAPID DRAWDOWN CASE

CASE	CHANGE IN GSL (ft)
BASE CASE	GSL @ 17' based on F.S. = 1.2
SOIL STRENGTH low strength high strength	 6 ft WEST 4 ft EAST
WATER DRAWDOWN large drawdown small drawdown	 6 ft WEST 4 ft EAST

1. Sensitivity studies indicate that the location of the Acceptable Factor of Safety line (Yellow Line) can be limited by a band 15 feet wide (13 to 28 ft wide).
2. Based on engineering judgement and the results of static slope stability analyses, the GSL should be defined by a "thick" line extending from 18 ft to 20 ft from crest of bank.



(a) Sliding Wedge Divided Into Slices



(b) Forces Acting On Slice

FIGURE B1
METHOD OF SLICES
CORVALLIS RIVERBANK

CH2MHILL

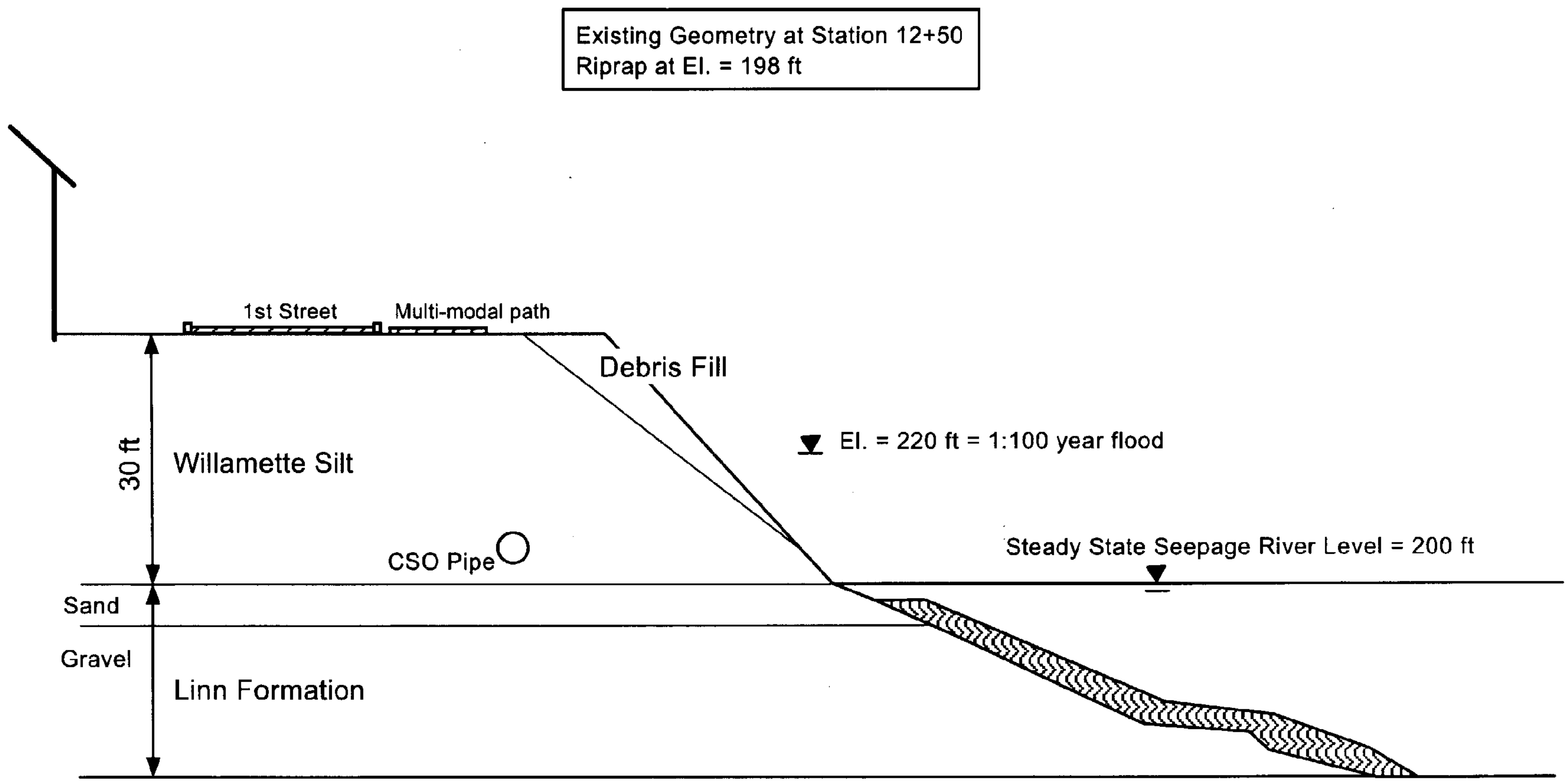


FIGURE B2
TYPICAL RIVERBANK SECTION
AT PINCH POINT
CORVALLIS RIVERBANK

CH2MHILL

Existing Geometry at Station 12+50
Riprap at El. = 198 ft

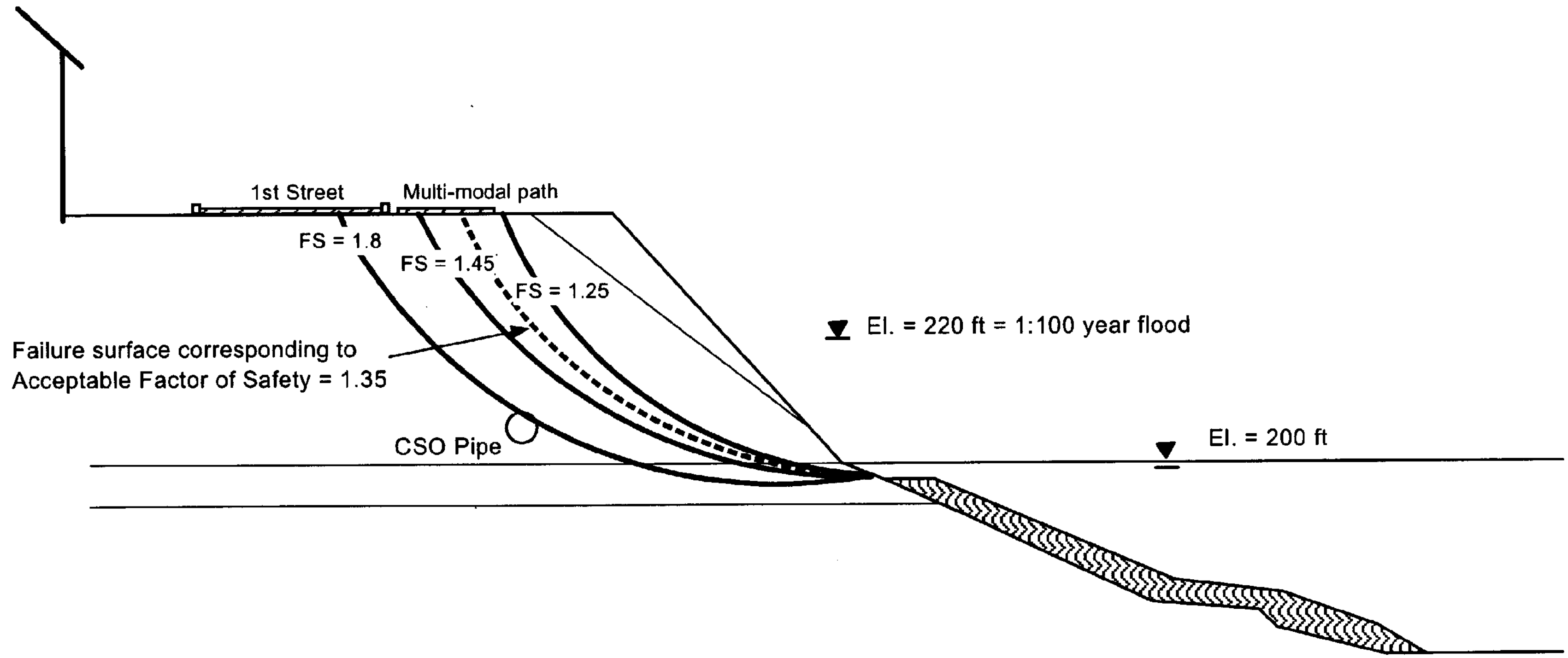
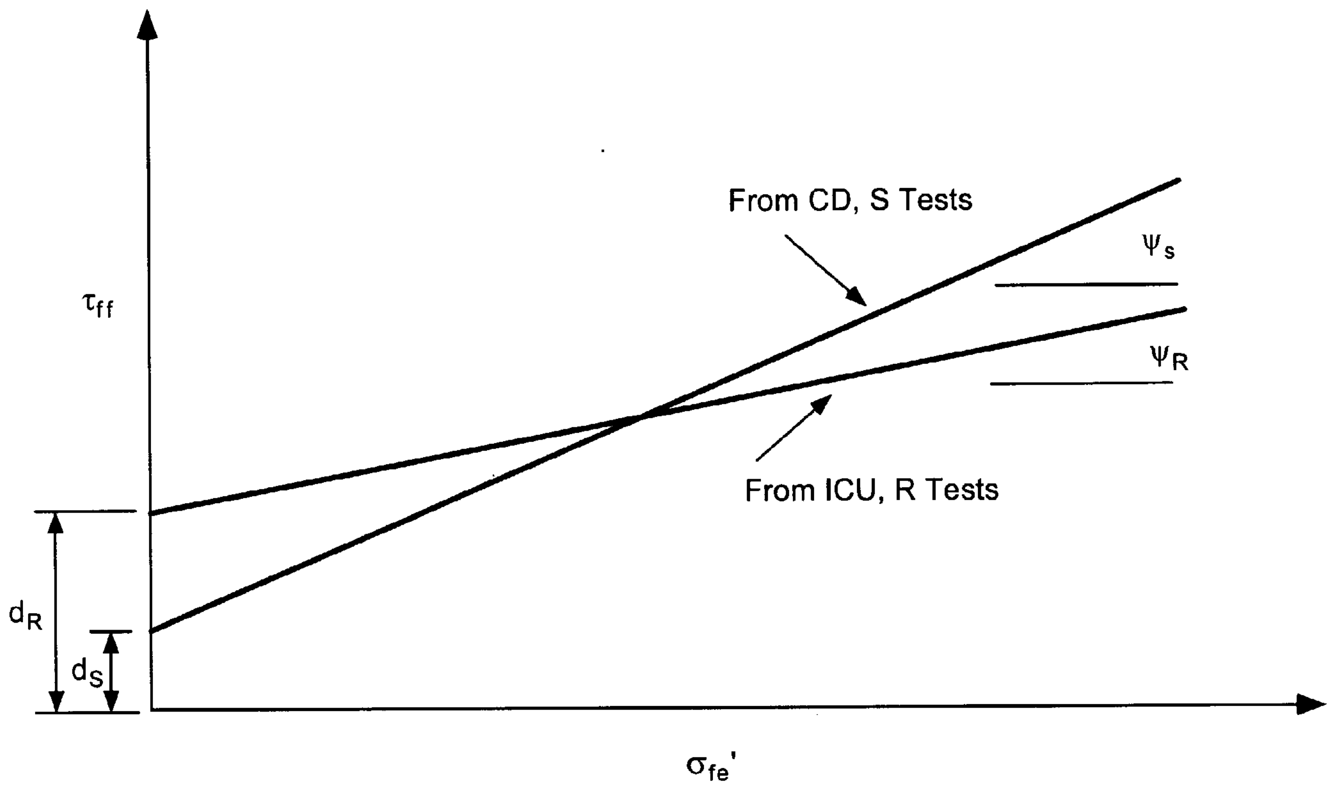


FIGURE B3
CIRCULAR FAILURE ANALYSIS
STEADY STATE SEEPAGE
CORVALLIS RIVERBANK

CH2MHILL



Note:
Shear strength envelopes used to compute shear strengths for second stage of two-stage stability computations

FIGURE B4
SHEAR STRENGTH ENVELOPES
FOR RAPID DRAWDOWN ANALYSES
CORVALLIS RIVERBANK

CH2MHILL

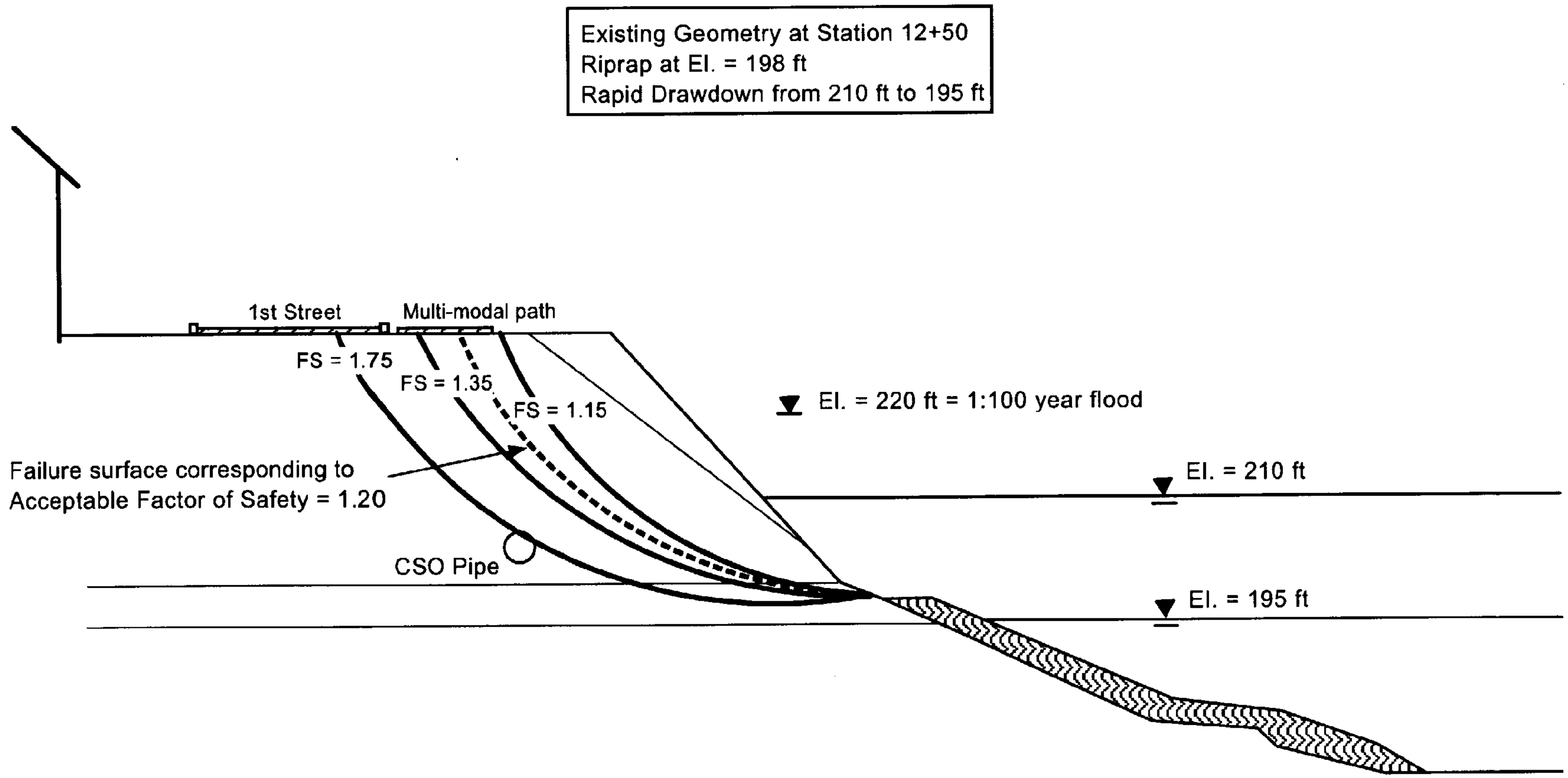
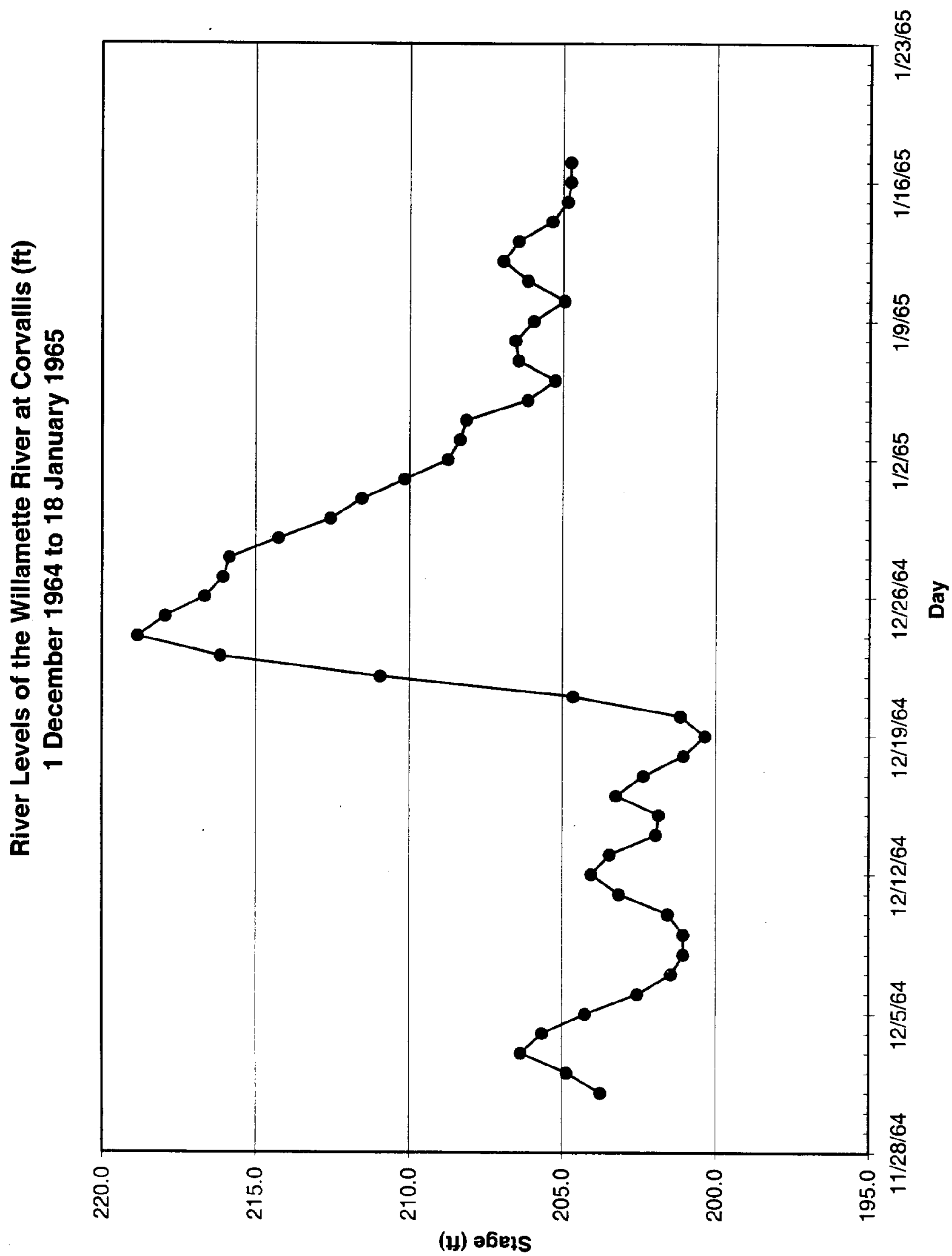
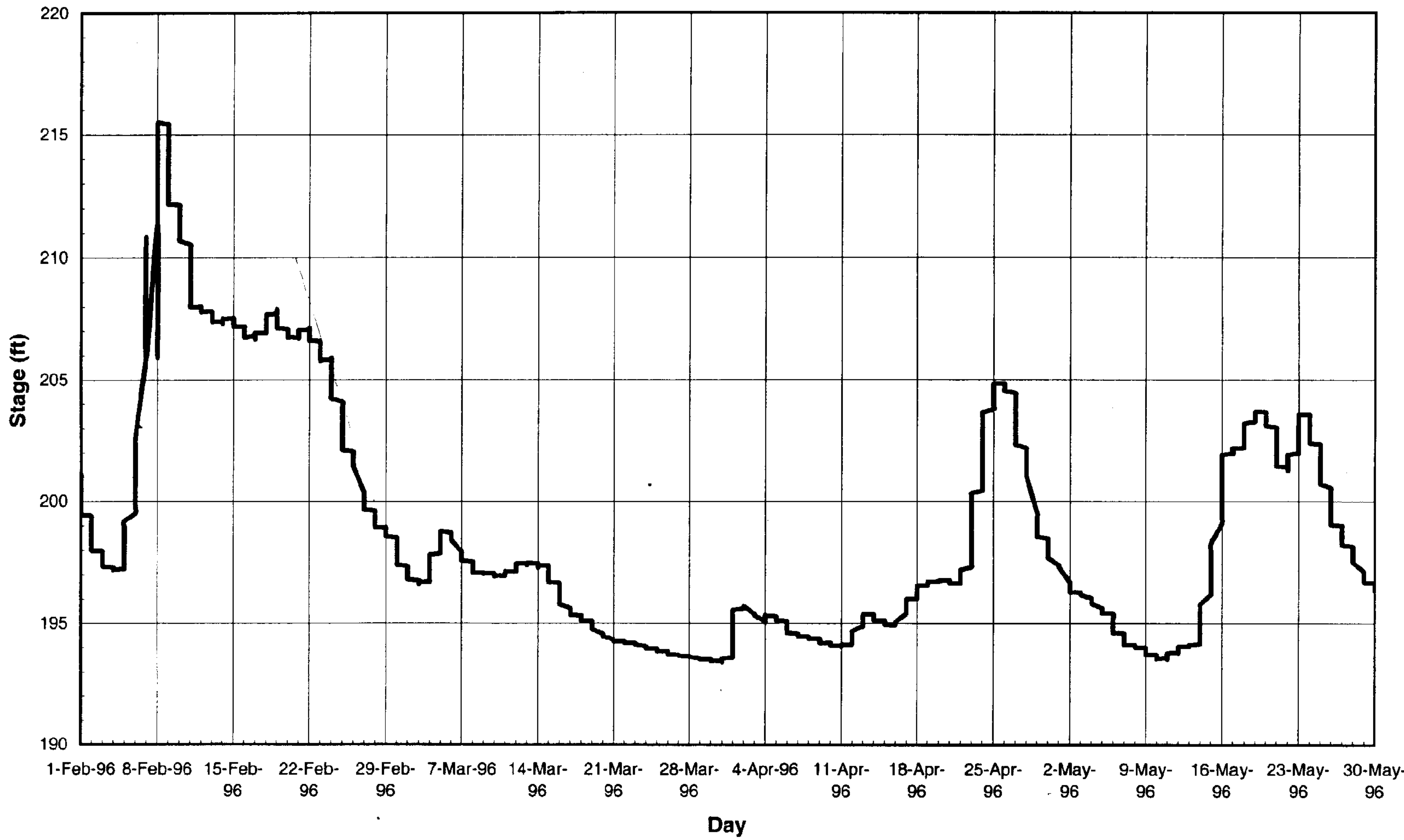


FIGURE B5
CIRCULAR FAILURE ANALYSIS
RAPID DRAWDOWN
CORVALLIS RIVERBANK

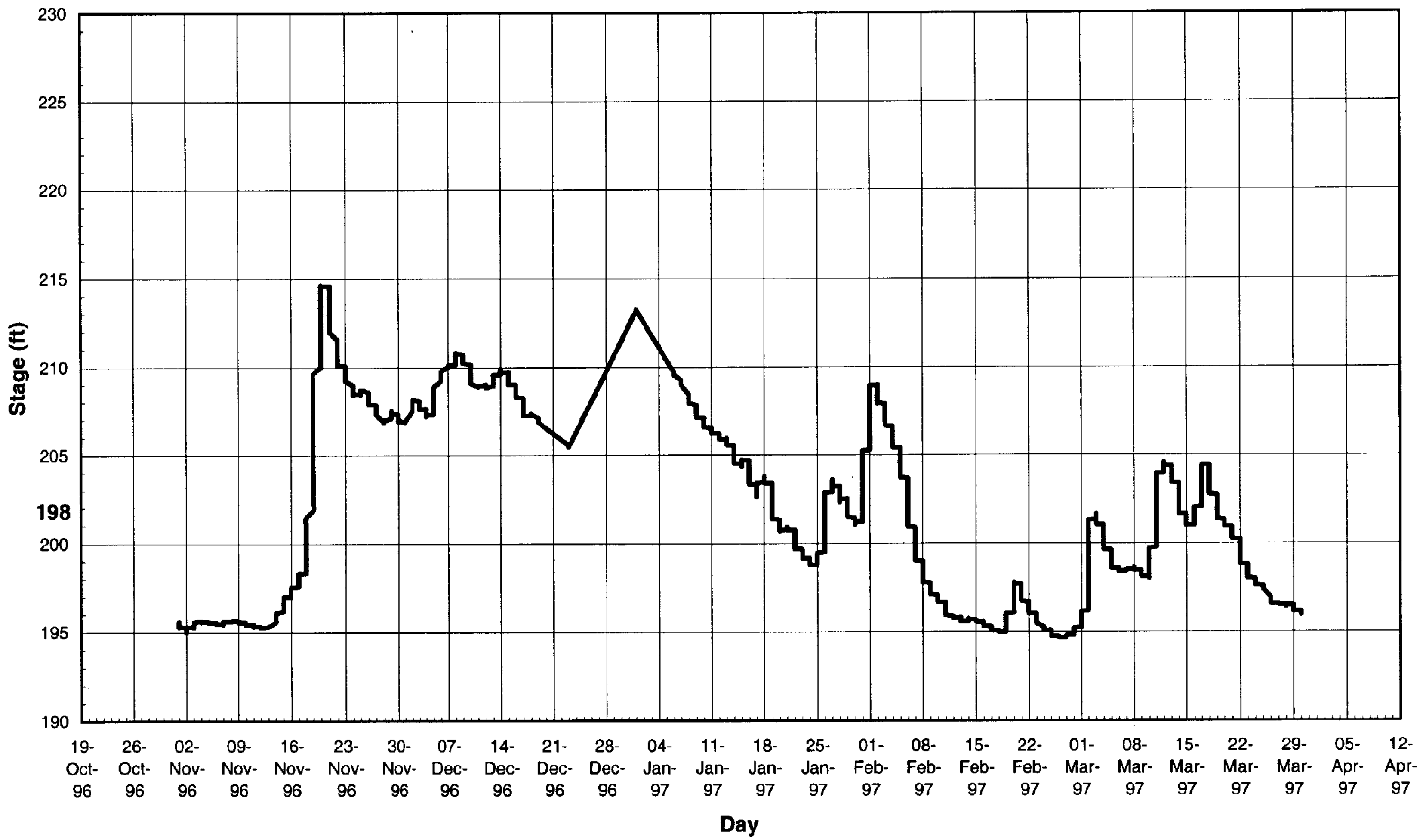
CH2MHILL


River Levels of the Willamette River at Corvallis (ft)
1 December 1964 to 18 January 1965
Stage (ft)
220.0
215.0
210.0
205.0
200.0
195.0
Day
11/28/64
12/5/64
12/12/64
12/19/64
12/26/64
1/2/65
1/9/65
1/16/65
1/23/65

River Levels of the Willamette River at Corvallis (ft)
1 February - 30 May 1996



River Levels of the Willamette River at Corvallis (ft)
1 November 1996 - 30 March 1997



(1)

LETTER OF TRANSMITTAL

FOUNDATION ENGINEERING
Professional Geotechnical Services
5030 SW Philomath Boulevard Corvallis, Oregon 97333 (541) 757-7645 Fax: (541) 757-7650

Date: March 1, 1999

Project No.: 98300078-308

Re: CH2M Hill 1998 Lab Testing - Corvallis River Bank

To: CH2M Hill, Inc.
2300 NW Walnut Blvd.
P.O. Box 428
Corvallis, OR 97339

Attn: Paul Davis/Vince Rybel

Enclosed are:

__ Report
__ Copy of Letter
__ Other:
__ Drawings
__ Specifications
x Test Results

Copies	*Date*	*Description:*
1	March 1, 1999	laboratory testing results

These are transmitted as checked below:

x For your use
x As requested
__ For your review/approval
__ For your files

Remarks: Requested laboratory testing results attached. Please call if you have any questions.

Copy to:

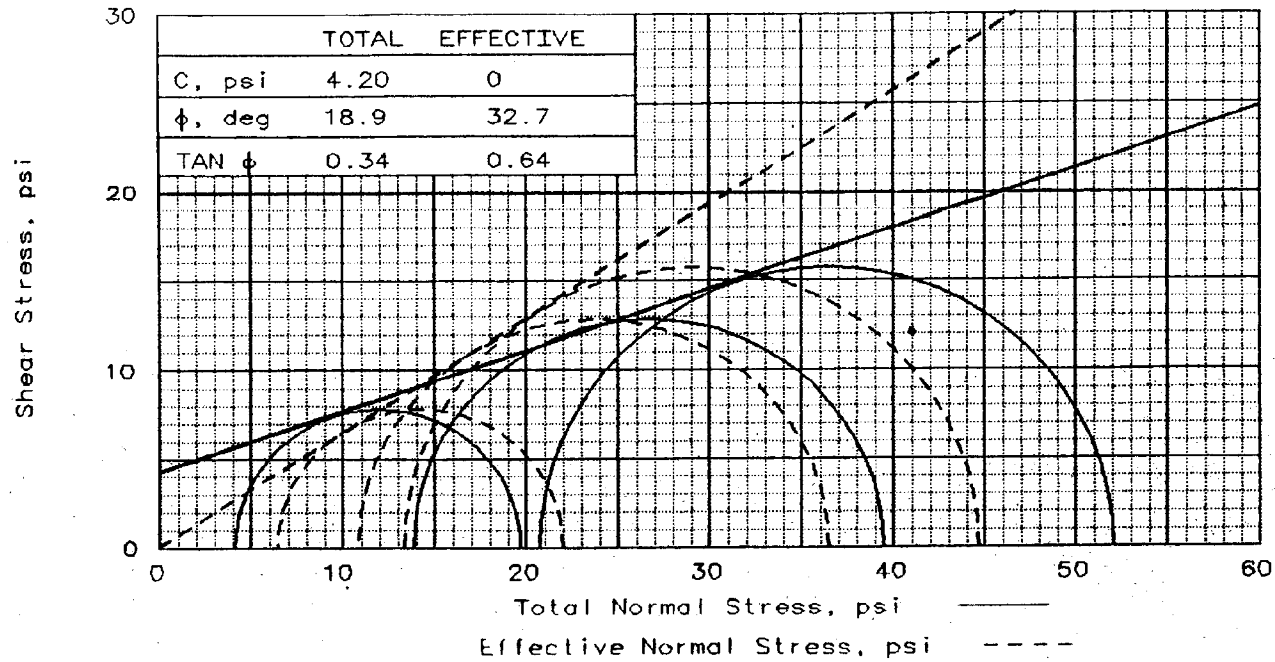
Signature:

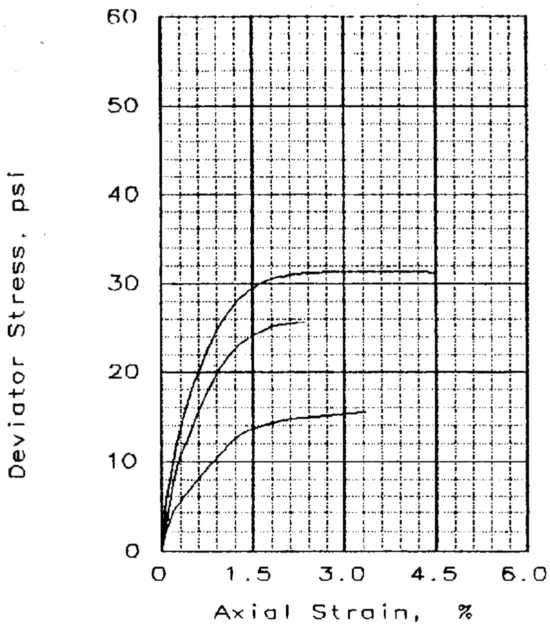
Brooke Fiedorowicz

Brooke K. Fiedorowicz
Assistant Laboratory Manager

Table 1. Natural Water Content and Atterberg Limits

Sample Number	Sample Depth (feet)	Natural Water Content (percent)	LL	PL	PI	USCS Classification
B-13-99, 3-ST	15.0 - 17.0	29.5	40	24	16	CL





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	29.9	29.9	29.9
	DRY DENSITY, pcf	86.0	86.0	86.0
	SATURATION, %	85.9	85.9	85.9
	VOID RATIO	0.923	0.923	0.923
	DIAMETER, in	2.88	2.88	2.88
	HEIGHT, in	6.39	6.39	6.39
AT TEST	WATER CONTENT, %	34.1	32.7	31.9
	DRY DENSITY, pcf	86.9	88.7	89.7
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.904	0.866	0.845
	DIAMETER, in	2.87	2.90	2.92
	HEIGHT, in	6.37	6.11	5.94
Strain rate, %/min		0.08	0.08	0.08
EFF CELL PRESSURE, psi		4.2	13.9	20.8
FAILURE STRESS, psi		15.5	25.6	31.3
TOTAL PORE PR., psi		44.7	49.7	54.1
STRAIN, %		3.4	2.4	3.1
ULTIMATE STRESS, psi				
TOTAL PORE PR., psi				
STRAIN, %				
$\bar{\sigma}_1$ FAILURE, psi		22.0	36.5	44.7
$\bar{\sigma}_3$ FAILURE, psi		6.5	10.9	13.4

TYPE OF TEST:
CU with Pore Pressures

SAMPLE TYPE: Extruded

DESCRIPTION: Brown silty CLAY

LL= 40 PL= 24 PI= 16

SPECIFIC GRAVITY= 2.65

REMARKS: Sample: B-13-99, 3ST
at 15.0 - 17.0 feet

Fig. No.: 1

CLIENT: CH2M Hill

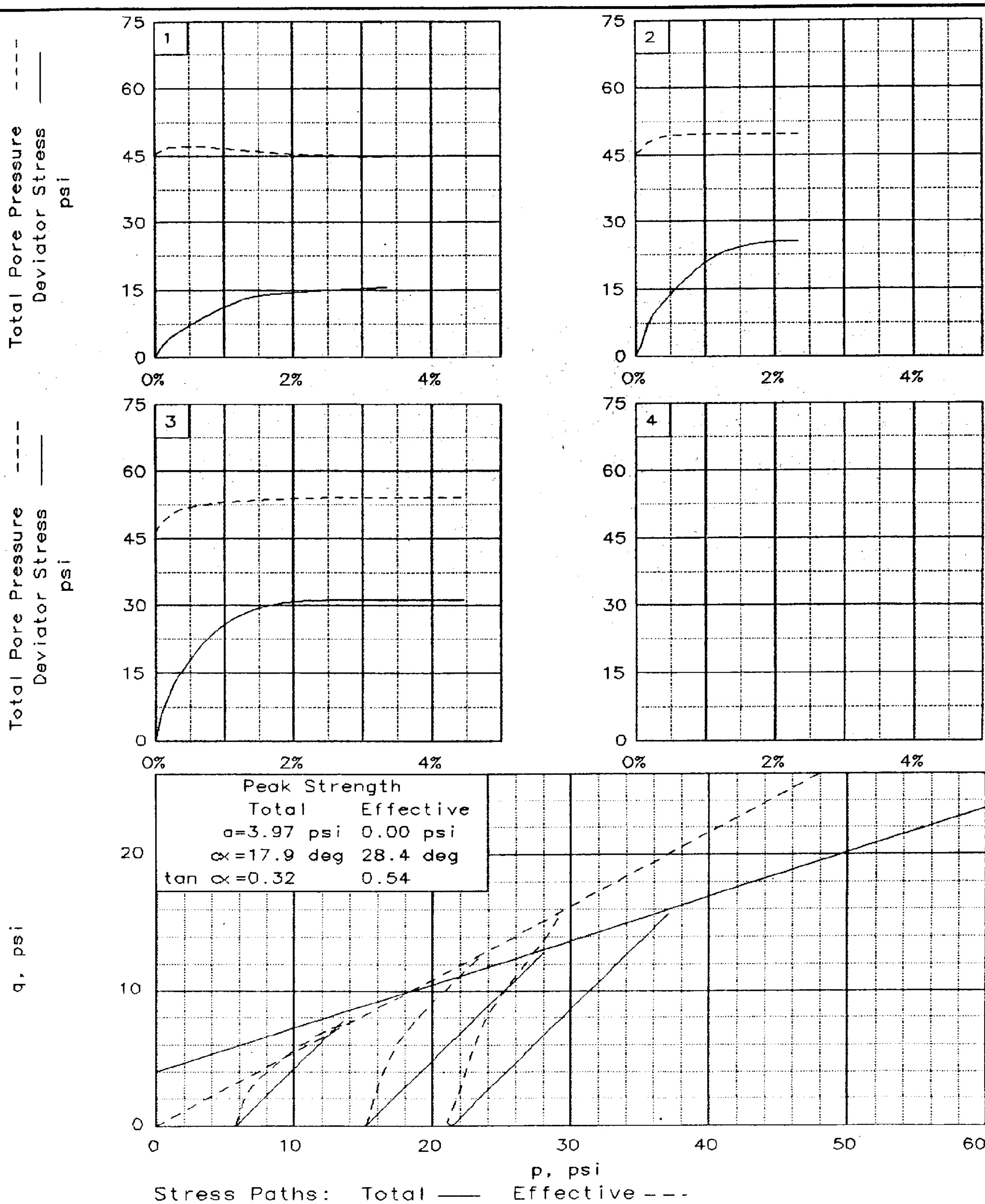
PROJECT: CH2M Hill: Corvallis River Bank

SAMPLE LOCATION: Corvallis, Oregon

PROJ. NO.: 98300078-308 DATE: 02-24-99

TRIAXIAL SHEAR TEST REPORT

Foundation Engineering, Inc.



Client: CH2M Hill
Project: CH2M Hill: Corvallis River Bank
Location: Corvallis, Oregon
File: CH2MHILL Project No.: 98300078-308 Fig. No.: 1